Fort Nelson Timber Supply Area

Timber Supply Review 3
Analysis Report
November, 2005

Prepared for: Fort Nelson Timber Supply Area Defined Forest Area Management (DFAM) Group

CANFOR

BC
Timber
Sales

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TSR 3 Timber Supply Analysis Report

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For Information on the Timber Supply Review Process

This report is a supporting document to facilitate the allowable annual cut determination by British Columbia's chief forester. For more information about this process, please visit the Forest Analysis and Inventory Branch website at:

http://www.for.gov.bc.ca/hts/

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Comments or Questions on the Analysis Report

First Nations and public input are valuable to the timber supply review process and you are encouraged to review the document and send any comments or questions to Chris Niziolomski by January 16, 2006.

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http://www.forestecosystem.ca/FortNelsonDFAMTSR3.html

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Canadian Forest Service – Pacific Forest Region

Executive Summary

This report describes the timber supply analysis for the Fort Nelson Timber Supply Area (TSA). Timber supply analysis examines the effects of current forest management practices on the short-, mid- and long-term availability of timber for harvesting. The analysis includes an assessment of the potential changes in timber supply resulting from uncertainties associated with assumptions in forest growth, harvest scheduling, and management actions. The purpose of this report is to provide the chief forester of British Columbia with sufficient information to make an informed Allowable Annual Cut (AAC) determination[1]. The current AAC of 1,500,000 cubic metres was determined in September of 2001. As part of the current Timber Supply Review (TSR) 3 process, the chief forester will determine a new AAC by September 2006 for the Fort Nelson TSA.

The key documents in supporting the AAC determination for TSR 3 are: 1) the data package, which describes the inputs and assumptions regarding current forest management practices, policies and legislation in the timber supply analysis, 2) the timber supply analysis (this report) and 3) the socio-economic analysis. The data package and the socio-economic report are appendices to this report.

This report focuses on a base case scenario, which reflects the current forest management practices in the Fort Nelson TSA. In addition, 28 sensitivity analyses were performed to assess the risk and uncertainties in the data, land base, and modeling assumptions.

The Fort Nelson TSA covers 9.9 million hectares in the northeast corner of British Columbia. The portion of this area that is considered available for timber production and harvesting under current forest management practices is called the timber harvesting land base (THLB). The THLB is determined through a net-down process where reductions are systematically excluded from harvesting based on physical, economical, social, cultural, ecological and environmental factors. In the Fort Nelson TSA, the THLB is estimated to be 1,432,269 hectares, a 55% increase over TSR 2. The main reasons for the THLB increase are the inclusion of the Cassiar Addition, the inclusion of more immature aspen stands based on different site productivity criteria, and the inclusion of small pine stands.

The base case forecast indicates that a harvest rate of 3,163,000 cubic metres per year can be maintained throughout the short and long-term (e.g. for 250 years). The harvest rate represents the total harvest from coniferous- and deciduous-leading stands. Over a 250-year period, the average harvest from coniferous species is 1,719,500 cubic metres per year and 1,443,500 cubic metres per year for deciduous species. However, there is enough flexibility in the base case harvest level for targeting a higher coniferous harvest in the first 35 years.

The base case harvest forecast was modelled as an even flow projection. As a result, the sensitivity analyses demonstrate that there is surplus growing stock in the short-and medium-terms, which acts as a volume reserve that can be drawn upon in the event of downward pressures on the timber supply. Because the analysis aims to maintain a sustainable harvest level in the short-, medium- and long-term without a fall-down effect, the harvest flow is constrained by its long-term growing stock.

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[1] It is important to note that the various harvest forecasts included in this report indicate only the timber supply implications of current practices and uncertainty. As such, the forecasts should be used for discussion purposes only: they are not allowable annual cut recommendations.

In order to assess the impacts of potential changes to modelling and management assumptions and gain further understanding of the dynamics in the base case, several sensitivity analyses were completed. Some of the factors and uncertainties that have an upward pressure on the harvest level throughout the entire 250-year planning horizon include:

- Planting spruce seedlings with a genetic gain,
- Realizing higher net volumes from harvesting of future stands,
- Redefining operability by reducing the minimum site productivity thresholds for immature pine and aspen, and
- Harvesting of birch-leading stands.

Because of the surplus growing stock in the base case, most of the uncertainties that were tested were alleviated in the short-and medium-term (e.g. next 100 years), which allowed for a base case harvest level to be maintained for the same period. The following factors maintained a short- to medium-term base case harvest but reduced the long-term harvest level by at least 3%:

- Reducing the timber harvesting land base area,
- Excluding harvest in small pine stands,
- Reducing future stand yields by ten percent,
- Using site index estimates based on site series (SIBEC) on conifer-leading stands in areas with Predictive Ecosystem Mapping (PEM) and Terrestrial Ecosystem Mapping (TEM),
- Increasing visual green-up height requirements by five metres,
- Redefining operability by increasing the minimum site productivity thresholds for all species immature stands,
- Applying lower allowable disturbance limits in visually sensitivity areas, and
- Excluding harvest in the 'Fort Nelson West' area, small pines, and low site immature aspen stands.

Unlike the factors discussed above where downward pressures on the base case occur in the long-term, the modelling of biodiversity requirements based on natural disturbance units (rather than based on landscape units as in the base case) placed significant downward pressures throughout most of the planning horizon. A possible reason for the harvest reduction is the targets for old forests are generally greater than those required under the base case.

A socio-economic analysis was also completed to highlight the importance of the forest industry to the Fort Nelson TSA and the province. Based on facts and data collected, it was concluded that the base case harvest forecast of 3,163,000 cubic metres per year could annually support the following:

- Estimated 2,227 person-years (PY) of total employment and $95.5 million of employment income in the Fort Nelson TSA,
- Estimated 5,029 PYs of total employment and $195.9 million of employment income in the province, and
- Estimated $85.4 million in stumpage and BC government revenues.

The actual employment and community related impacts would depend on the actual AAC set by the provincial chief forester and the ability of the forest industry to economically harvest and process the timber.

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1 Introduction

Timber supply is the amount of timber that is forecast to be available for harvesting over time for a specific area, under a particular management regime. The Timber Supply Review (TSR) process facilitates the public and First Nations' review of the timber supply analysis, the incorporation of their inputs into the analysis, and the determination of allowable annual cuts (AAC*) by British Columbia's chief forester.

Under the Defined Forest Area Management (DFAM) initiative, it is the collective responsibility of the DFAM group to conduct timber supply analysis at least once every 5 years to ensure that current data, management assumptions, legislation, and other initiatives are reflected in the AAC. The Fort Nelson DFAM group includes the holders of replaceable forest licenses (Canadian Forest Products Ltd is the only major licensee in the Fort Nelson TSA) and BC Timber Sales. Forest Ecosystem Solutions Ltd, on behalf of the Fort Nelson DFAM group, has prepared this timber supply analysis.

This report contains the data package, timber supply analysis and socio-economic analysis (SEA) for the Fort Nelson Timber Supply Area (TSA). The data package describes inputs and assumptions regarding current forest management practices, policies and legislation in the timber supply analysis (Appendix 4). The SEA assesses the current and possible future contribution to employment and income by the forest industry. As part of the chief forester's AAC determination, the SEA will provide the capabilities and requirements of existing and proposed processing facilities, along with the social and economic objectives of the Crown. The SEA is presented in Section 7.

To determine allowable timber harvesting levels accurately and rationally, the chief forester must have an up-to-date assessment of the timber supply, based on the best available information and reflecting current management direction. This report provides the information to support this assessment and should not be considered as a recommendation on permissible harvest levels.

An important part of the timber supply analysis is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the base case provide a basis for discussions among stakeholders about alternative timber harvesting levels and considerations by the chief forester in determining the AAC.

This analysis report identifies a base case forecast, which represents a single forest management scenario demonstrating current management practices. Current management practices are defined by various plans, documents and legislation for the timber supply area including guidelines for forest resources protection, the *Forest Practices Code* (FPC), *Forest and Range Practices Act* (FRPA), and official land-use decisions made by Cabinet. In the Fort Nelson TSA, the following legislation and policy/management guidelines apply:

***Acronyms are defined in Appendix 2. Words with an asterisk are also defined in a glossary in Appendix 3.**

- *Forest Practices Code* (at the time of preparing the data package, the FPC was still in force and assumptions are based on the FPC with transition considerations to FRPA.)
- *Forest and Range Practices Act*
- *Fort Nelson Land and Resource Management Plan*, October 1997
- *Muskwa-Kechika Management Area Act*, July 1998
- *Muskwa-Kechika Management Plan*, October 1997
- *Provincial Wildlife Tree Policy and Management Recommendations*, 2002
- *Order Establishing Provincial Non-Spatial Old Growth Objectives*, June 2004
- *Landscape Unit Planning Guide*, 2000
- *Identified Wildlife Management Strategy*, 1999
- Modelling Visuals in TSR III Bulletin, 2003
- District Manager Direction Letter on Making Scenic Areas Known and Establishing Visual Quality Objectives, August 28, 1997
- Approved Forest Development Plans

This report contains a brief description of the TSA (Section 2), a discussion of data preparation and formulation of assumptions (Section 3), the results of the base case analysis (Section 4), an examination of uncertainties in the data and assumptions through sensitivity analyses (Section 5), a summary and conclusions of the base case and sensitivity analyses (Section 6) and a socio-economic analysis (Section 7).

1.1 Process

The requirement to conduct timber supply analysis on a periodic basis (at least once every 5 years) is the collective responsibility of the DFAM group. In the Fort Nelson TSA, the DFAM group consists of BC Timber Sales (BCTS) and Canadian Forest Products Ltd (Canfor) – Fort Nelson Division. In preparing this timber supply analysis for the Fort Nelson TSA, the DFAM group have followed the *Interim Standards for Data Package Preparation and Timber Supply Analysis, DFAM Initiative*. The roles and responsibilities for the specific timber supply review steps are outlined Table 1.

Following the completion of these steps, the chief forester or designate will review the final timber supply analysis report, assess its acceptability for supporting the AAC determination, and if necessary request additional information. After acceptance of the analysis, the chief forester determines the AAC while considering all the factors as required in the *Forest Act*, section 8 (8). These factors include the objectives of the Crown, the capability of the land base to support a sustainable harvest, and public and First Nations' interests.

The previous TSR (TSR 2) for the Fort Nelson TSA was completed in March 2000 with the AAC determination in September 2001. The current TSR 3 process is ongoing with the AAC determination to be completed at latest by September 2006 (5 years following the last determination). Four primary documents will be provided through this process: 1) the data package, 2) the draft base case report, 3) the analysis report (this report) and 4) the rationale for AAC for the TSA report by the chief forester. The data package is a technical document that summarizes the data and inputs for the analysis. The draft base case report provides a harvest forecast based on current management practices with supporting diagnostic summaries, and serves as the base line for which sensitivity analyses are compared against. The analysis report summarizes the results from the timber supply analysis and socio-economic analyses and serves as the key document for public discussion. The report on the Rationale for AAC by the chief Forester will identify the new AAC for the Fort Nelson TSA and outline the chief forester's decision and supporting rationale.

In the current TSR process, the data package was submitted to the Ministry of Forests (MoF[2]) as well as for public and First Nations' review on Jan. 31, 2004. The review process was completed by March 31, 2004 and a revised data package, which incorporates the review comments, was submitted to the MoF on July 9, 2004. The July 9, 2004 version of the data package was approved by the MoF's timber supply analyst on Oct. 13, 2004. Since the approval, changes were made to the non-forest area, which resulted in an additional 12 ha in the timber harvesting land base (1,432,269 ha vs. 1,432,257 ha) and 106,932 ha in the Crown forested land base (5,741,212 ha vs. 5,635,280 ha). Details regarding the changes to the non-forest areas and current data and management assumptions are provided Appendix 4.

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[2] As of June 2005, the Ministry of Forests was renamed the Ministry of Forests and Range; the Ministry of Water. Air and Land Protection was renamed the Ministry of Environment; and the Ministry of Sustainable Resources Management was renamed to the Ministry of Agriculture and Lands. To recognize and credit those individuals who have provided data and guidance for the completion of this analysis report and who at the time were working under the old Ministries' names, this report will continue to reference the old Ministries' names.

Table 1: Timber supply review steps with roles and responsibilities

DFAM Group	BC Ministry of Forests		Schedule
	Forest Analysis Branch	**District & Regional Staff**	
Compiling data needed for the timber supply analysis, including forest cover and other data related to forest and land characteristics, administration and management regimes.			April 2003-Dec. 2004
Providing information to the public and First Nations (government retains consultation responsibilities with respect to First Nations).			April 2003-present
Compiling a data package that documents the data, management strategies, and methods that will be applied in the timber supply analysis, according to standards provided by the Ministry of Forests (*Supplemental Guide for Preparing Timber Supply Analysis Data Packages* is used as a template for this data package).	Reviewing and accepting the data package (focus on how data is to be applied in timber supply analysis).	Reviewing the data package (confirming current practice).	Data Package (July 9, 2004 version) was accepted by the MoF timber supply analyst on Oct. 13, 2004.
Performing and documenting a timber supply analysis according to standards provided by the Ministry of Forests.			Oct. 2004 – July 2005
Submitting a file containing the complete dataset used in the timber supply analysis. This requirement is primarily to assist government in compiling and maintaining a complete coverage of the province for tracking of land base, management, and other strategic issues, as well as to enable audit analysis.	Reviewing and accepting (together with the chief forester) the analysis report	Reviewing the analysis report to ensure local issues and current practices are adequately reflected.	Ongoing
Provide information to the public and First Nations and summarize comments received for government.		Conduct formal consultation.	Ongoing
Providing additional information as required by the chief forester.	Compiling and preparing information, primarily from the analysis report, for presentation to the chief forester for the AAC determinations.	Assisting in compiling and preparing information, primarily from the analysis report, for presentation to the chief forester for the AAC determinations.	Ongoing. AAC Determination to occur before Sept. 2006.

2 Description of the Fort Nelson TSA

The Fort Nelson TSA is situated in the north-eastern corner of British Columbia within the Northern Interior Forest Region (Figure 1). This TSA, administered from the Fort Nelson Forest District office in Fort Nelson, is the second largest timber supply area in the province, covering more than 9.9 million hectares. The Fort Nelson TSA is bordered on the east by Alberta, on the north by the Northwest and Yukon Territories, on the west by the Cassiar TSA and Rocky Mountains, and on the south by the Fort St. John and Mackenzie TSAs.

The TSA encompasses parts of the Alberta plateau, the Rocky Mountain Foothills, the Liard Plateau, the Liard Plain, the Kechika River Valley and a portion of the Cassiar Mountains. This entire region is within the Arctic watershed and is largely drained by the Liard River and its major tributaries, including the Fort Nelson, Prophet, Muskwa, Toad, Kechika and Petitot rivers. The topography forms a gradient of increasing relief from east to west.

The southeastern portion of the TSA overlaps with the Muskwa-Kechika Management Area (M-KMA), which covers over six million hectares including areas in the Mackenzie and Fort St. John TSAs. The M-KMA is a significant wilderness and wildlife habitat area that supports a diverse range and sizeable populations of large mammals. Resource developments such as recreation, range, logging, mining, and oil and gas developments may occur but also require higher standards of management to accommodate the cultural and environmentally sensitivities in this area.

About 58% of the Fort Nelson TSA is considered productive forest area (about 5.7 million hectares) and currently 25% of that productive forest (or 15 % of the total TSA) is considered available for timber production. The current AAC of 1,500,000 cubic metres was established in 2001 with a partition of 600,000 cubic metres per year for coniferous-leading species and 900,000 cubic metres per year for deciduous–leading species.

The main community is the town of Fort Nelson, where three-quarters of the TSA's population reside while the remainder of the population live in other communities including Prophet River, Toad River, and Muncho Lake. The Fort Nelson Forest District encompasses the Fort Nelson timber supply area and also includes Muncho Lake Park, Stone Mountain Park, Northern Rocky Mountains Park and part of the Muskwa-Kechika Management Area, as well as several other small parks and protected areas. As of 2001, there are 39 parks, protected areas and ecological reserves in the Fort Nelson TSA, totalling 1,052,516 ha or 10.7% of the TSA. A list of these parks is provided in Appendix 9.

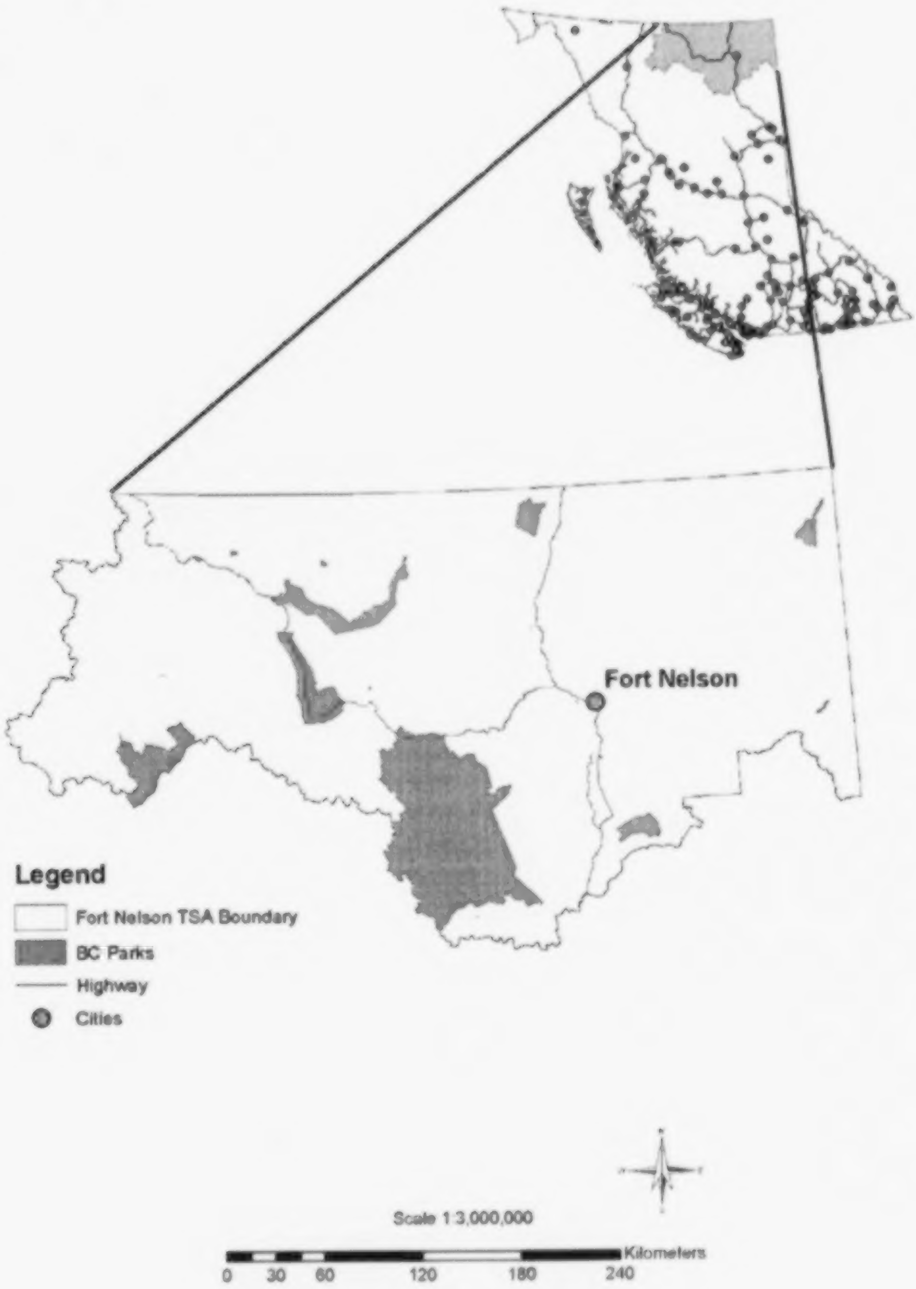
Fort Nelson
Legend
Fort Nelson TSA Boundary
BC Parks
Highway
Cities
Scale 1:3,000,000
Kilometers
0
30
60
120
180
240

Figure 1: Geographic location of Fort Nelson TSA

2.1 The Environment

The Fort Nelson TSA contains three biogeoclimatic zones*: Boreal White and Black Spruce (BWBS), Spruce Willow Birch (SWB) and Alpine Tundra (AT). The dominant biogeoclimatic zone is the BWBS zone, which covers about two-thirds of the TSA's land base. The biogeoclimatic zones, their locations, the major tree species present, and other considerations such as climate and wildlife values are summarized in Table 2. The area in the crown forested land base by biogeoclimatic subzones is shown in Figure 2; the alpine tundra comprises of 1.3 million hectares but is not considered part of the crown forested land base.

Table 2: Biogeoclimatic zones of the Fort Nelson Timbers Supply Area

Zone	Location	Tree species	Other
Boreal White and Black Spruce	Covers most of the eastern portion of the TSA, up to an elevation of 1300 metres. Occupies 69% of the TSA land base.	Dominant: white spruce, lodgepole pine, trembling aspen. Minor: black spruce, balsam poplar, tamarack, subalpine fir, common paper birch and Alaska paper birch.	Long, very cold winters and short growing seasons. Rich in wildlife.
Spruce Willow Birch	On middle elevations of northern Rocky Mountains, Cassiar Mountains and much of the Liard Plateau (1300 metres to 1500 metres). Occupies 17% of TSA land base.	**Lower elevations** Dominant: white spruce and subalpine fir. Minor: black spruce, lodgepole pine and trembling aspen. **Upper elevations** Dominated by tall deciduous shrubs (birch, willow species).	Harshest climate of all forested zones in B.C. Winters long and cold, summers short and cool. Major wildlife use in summer months.
Alpine Tundra	Above 1500 metres in the south west side of the TSA. Occupies 14% of TSA land base.	Trees generally absent. Plants are small, close to ground, and often widely separated by bare soil or rock.	Harshest climate of all B.C. zones. Wildlife diversity and occurrence are low.

In British Columbia, the Boreal White and Black Spruce Zone has the least snowfall of all the northern zones and consequently is very important for wintering ungulates. Also in this zone, frequent forest fires have formed a mosaic of upland forests of different ages, providing a variety of habitats. The extensive deciduous forests frequently achieve older ages and are important for ungulates, birds and small mammals.

The severe climate of the Fort Nelson TSA limits wildlife occurrence in some isolated portions or at certain times of year. However, this TSA also contains vast tracts of relatively undeveloped land that support abundant, diverse and internationally significant wildlife populations. Large mammals such as moose, black and grizzly bear are common, as are smaller furbearers such as wolverine, wolf, lynx, weasel, mink, river otter, beaver and coyote.

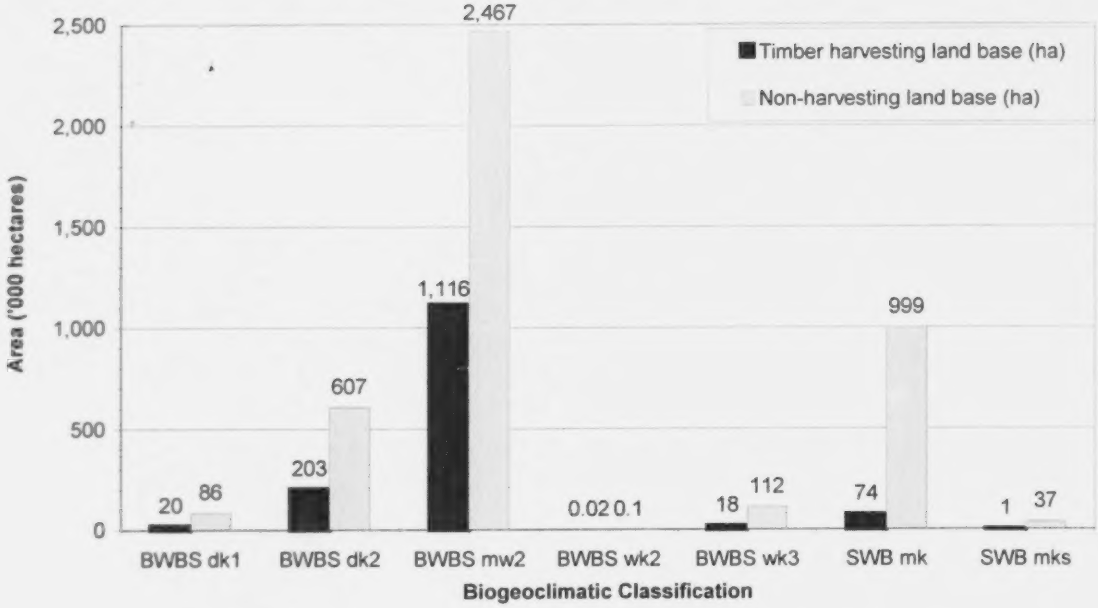

Figure 2: Area (hectares) by biogeoclimatic ecosystem classification in the Fort Nelson TSA

The TSA contains a unique range of bird species (i.e. Bay-breasted Warbler, Black-throated Green Warbler, Cape May Warbler, Connecticut Warbler, Nelson's sharp-tailed sparrow, trumpeter swam, etc.); many of which are not found elsewhere in BC. The abundant rivers, lakes, and wetlands provide important staging grounds during the migration of water birds such as pintails, widgeons, geese and teal. There are few species of reptiles and amphibians.

The waterbodies in this area support many important game fish species. These include some trout species, whitefish, burbot, Arctic grayling, northern pike and walleye. The rare occurrence of some salmon species has also been noted in some of the major rivers. Approximately 15 game and non-game fish species occur only in this area of the province.

In the Fort Nelson TSA, there are 11 red-listed (endangered or threatened) species and 16 blue-listed (species of concern) species; some of which are also species at risk (Table 3). It is understood that these species are affected by forest and range practices and may require detailed habitat management prescriptions to sustain regional populations.

Table 3: List of red and blue-listed species in the Fort Nelson TSA

Endangered or Threatened (Red-listed)		Vulnerable (Blue-listed)	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**
Martes pennanti	Fisher	*Botaurus lentiginosus*	American Bittern
Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow	*Grus canadensis*	Sandhill Crane
Bison bison athabascae *	Wood Bison	*Salvelinus confluentus*	Bull Trout
Coregonus artedi	Cisco	*Ursus arctos**	Grizzly Bear
Coregonus autumnalis	Arctic Cisco	*Asio flammeus*	Short-eared Owl
Dendroica castanea	Bay-breasted Warbler	*Dendroica virens*	Black-throated Green Warbler
Dendroica tigrina	Cape May Warbler	*Gulo gulo luscus*	Wolverine, *luscus* subspecies
Notropis atherinoides	Emerald Shiner	*Hiodon alosoides*	Goldeye
Notropis hudsonius	Spottail Shiner	*Melanitta perspicillata*	Surf Scoter
Oporornis agilis	Connecticut Warbler	*Myotis septentrionalis*	Northern Long-eared Myotis
Pungitius pungitius	Ninespine Stickleback	*Rangifer tarandus* pop. 14*	Caribou (boreal population)
		Rangifer tarandus pop. 15*	Caribou (northern mountain population)
		Salvelinus malma	Dolly Varden
		Stenodus leucichthys	Inconnu
		Vireo philadelphicus	Philadelphia Vireo
		Wilsonia canadensis	Canada Warbler

*These species are also considered 'species at risk' under the federal Species At Risk Act

The protection of wildlife and the environment will primarily be managed through the *Forest and Range Practices Act* (FRPA) and through the *Identified Wildlife Management Strategy* (IWMS) as well as the Federal *Species At Risk Act* (SARA) legislation. The Ministry of Water, Land and Air Protection (MWLAP) is in the process of developing ungulate winter range (UWR) in the Fort Nelson TSA. The MWLAP's priorities to complete the UWR and IWMS are provided in Table 4. The MWLAP has also produced a list of Regionally Important Wildlife for the Peace Region, which includes mountain goat, caribou, Stone's sheep, northern goshawk, trumpeter swam, American bittern, arctic grayling, lake trout, and walleye. Once the list is approved by the MWLAP's Deputy Minister, management strategies for these wildlife will be developed.

Table 4: List of MWLAP priorities for developing ungulate winter range and IWMS.

Species	UWR Priority	IWMS Version 2 Priority
Northern and boreal caribou	High	High
Stone's sheep	Medium - High	
Elk	Medium - High	
Mountain Goat	Medium - High	
Wood Bison	Medium	
Moose	Low	
Mule deer	Low	
Bull trout		High
Fisher		Medium
Wolverine		Medium
Sandhill crane		Medium
Bay-breasted warbler		Medium
Cape May warbler		Medium
Connecticut warbler		Medium
Black-throated green warbler		Low
Nelson's sharp-tailed sparrow		Low
Grizzly bear		Low
Short-eared owl		Low

2.2 First Nations

There are eight First Nations that are resident or have traditional territory within the Fort Nelson TSA: Fort Nelson First Nation, the Dene Tsaa Tse K'Nai First Nation, Dena Tha' First Nation, Fort Liard First Nations, Lower Post First Nation, Dease River First Nation, Halfway River First Nation and Tahltan Indian Band. The Fort Nelson First Nation, the Dene Tsaa Tse K'Nai First Nation, and the Dena Tha' First Nation are signatories to Treaty 8, which covers the Fort Nelson TSA. The Fort Liard First Nation is part of Treaty 11 in the Northwest Territories. The Lower Post First Nation is currently not a signatory to any treaty process. Some of these First Nations members are employed directly or indirectly in the forest industry in the TSA. For more information on the First Nations community, their geographic location, cultural background and population, refer to the socio-economic analysis (Section 8.1, Table 32).

3 Data and Methods for Timber Supply Analysis

This section provides an outline of the data used and how it was applied in the Fort Nelson timber supply analysis. This information can be divided into four general categories: land base inventory, forest dynamics, management practices, and timber supply analysis methods. This section serves only as a summary and more detail can be found Appendix 4.

3.1 Land Base Inventory

Land base inventories contains information describing forest and non-forest land, their geographic location, area, nature of forest cover (such as presence or absence of trees, species, density, age, and timber volume), environmental sensitivities, and occurrence of fires or industrial activities. Most of the data used to prepare such an inventory was provided by the Ministry of Forests (MoF), the Ministry of Sustainable Resource Management (MSRM), Canadian Forest Products Ltd. and BC Timber Sales. A list of the data used for analysis is provided in the data package (Appendix 4, Section 12.1).

The data is typically prepared using geographic information systems (GIS), which provide the technology to manage and store data in a database and spatial digital files. The data listed in Appendix 4 is spatially combined together to create a master dataset or the land base inventory. The land base inventory is then used to determine whether land is forested or non-forested and whether timber harvesting is expected to occur or not, as determined by a netdown process.

An important aspect of the land base inventory is the forest inventory data. During 2002/2003, Fort Nelson Division of Canfor received funding from the Forest Investment Account to re-inventory approximately one third of the TSA following Vegetation Resource Inventory (VRI) standards. The remaining two thirds of the TSA contained old forest cover data, whose format have been "rolled-over" into the new VRI format. It should be noted that the "roll over" process does not generate a true VRI database. It maintains the old Forest Cover 1/Forest Inventory Program (FC1/FIP) inventory information in a new database format.

The completion of the VRI involved staff from BCTS and the Regional and District staff of MoF and MSRM. The VRI Phase I photo-interpreted inventory has projected stand attributes to 2003 whereas VRI "rolled over" was projected to 2002. The "rolled over" VRI comprises a total of 6,863,581 ha of the TSA and 3,004,473 ha are in VRI Phase I. VRI Phase II ground sampling provide data and associated adjustments for age, height and net volume, which have been applied to the VRI Phase I area (documented in Jahraus and Associates 2003).

Before the timber supply analysis can be completed, the area in the TSA that is managed by the MoF must be classified as forested or non-forested. Forested land managed by the MoF is referred to as the Crown forested land base (CFLB). The CFLB is composed of the timber harvesting land base (THLB) and the non-harvesting land base (NHLB).. An area can only be removed for one reduction type: for example, the area of a stand that falls within a park, and also has sensitive soils, is assigned only once to the non-harvesting land base.

The non-harvesting land base (NHLB) consists of forested areas where harvesting is not expected to occur because the land may be unproductive/inoperable, and/or may have significant non-timber values or use, such as riparian reserves and seismic areas. Areas that do not contribute to timber supply (e.g. the NHLB) are maintained for the analysis. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes to a mix of timber and non-timber values.

The timber harvesting land base (THLB) does not mean that it is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value — and sites of adequate environmental resilience — to accommodate timber harvesting with due care for other resources.

For the Fort Nelson TSA, the following types of areas are not part of the THLB but may be part of the forested land base (areas included and excluded from the crown forested land base are indicated below):

Areas that are not part of the crown forested land base and are not in the THLB

- non-Crown areas — areas not managed directly by the MoF (e.g., private land, federal reserves, Indian reserves, military reserves).
- woodlots—areas that are managed by the MoF but are not managed by the DFAM Group.
- non-productive areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-typed areas — areas for which inventory type information is unavailable (usually non-forest).
- alpine — high elevation areas identified as alpine tundra (AT) and subalpine parkland in the biogeoclimatic classification that were not deducted in other categories noted above, such as non-productive areas.
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- existing roads, trails and landings — areas of forest land that have been removed from timber production due to access development and harvesting to date, but are too small to be classified as non-forest area.

Areas that are part of the crown forested land base but not part of the THLB

- parks, ecological reserves, Use for Public Recreation, and Enjoyment (UREP) – areas designated for recreation use and/or ecological significance.
- not satisfactorily restocked (NSR) areas that have no history of harvesting and were created after a natural disturbance such as a wild fire, remain unproductive, or are misclassified. NSRs are areas not covered by a sufficient number of well-spaced tree stems of desirable species. Stocking standards are set by the BC Ministry of Forests.

- non-merchantable — areas covered by timber stands that are not currently used by local processing facilities.
- low timber productivity areas — areas occupied by forest that contain commercial tree species but have not, or will not, achieve a productive condition within a reasonable growing period to be considered economical for harvesting.
- riparian reserves — area otherwise available for timber production that is assumed to be unavailable for harvesting to provide protection for riparian ecosystems.
- environmentally sensitive areas (ESA) — areas considered to have wildlife or recreational significance, areas with highly sensitive soils, and areas where problems with regeneration are anticipated.
- unstable terrain- areas with unstable terrain, making it difficult for harvesting to occur.
- wildlife range areas — areas managed to promote wildlife grazing through use of prescribed fire.
- stand-level biodiversity — patches of standing timber larger than two hectares maintained within harvested areas to provide for the maintenance of stand structure over time.
- seismic activity — areas of forest land that have been removed from timber production due to extensive oil and gas exploration and development to date. Future forest depletion due to seismic activity will be incorporated into future analysis.
- Inoperable areas — inaccessible or uneconomical areas based on physical and economical factors
- black spruce stands — areas predominated by black spruce typically contain small stem sizes, which are currently not considered merchantable, and offer regeneration problems for future stands due to elevated water tables. Areas with black spruce as leading species will not be harvested. However, black spruce in mixed stands or in small pockets adjacent to other merchantable species may be harvested; therefore, black spruce as a minor component in mixed stands will contribute to the THLB.
- future roads, trails, landings and seismic areas— expected future losses of productive forest land due to development of roads and seismic lines . These areas are initially included in the THLB, but are subsequently removed after the first rotation.
- Future wildlife tree patches – expected future losses of THLB due to timber retention required for wildlife trees and wildlife tree patches. These areas are initially included in the THLB, and are subsequently removed after the first harvest.

A more detailed description of these categories, including specific criteria for removal is located in the data package (Appendix 4). A summary of the areas removed in each category listed above, and the area in the THLB is shown in Table 5 and a map of the THLB is shown on Figure 3.

Following the considerations described above a total of 4.1 million hectares are removed from the 9.8 million hectares for non-forest or non-productive conditions including specific reductions such as alpine areas, roads and non-commercial cover. The remaining 5.7 million hectares is considered productive forest and is referred to as the CFLB, which contains forests that contribute to landscape-level objectives such as old growth and visual quality objectives (VQOs). Areas in the CFLB that do not contain timber harvesting potential but contribute to non-timber values (i.e the non-harvesting land base) account for 4.1 million hectares of land and the remaining 1.4 million hectares comprise the THLB.

Table 5: Timber harvesting land base determination for the Fort Nelson TSA

Classification	Total Area (ha)	Net Area Removed (ha)	Percent of Total TSA area (%)	Percent of CFLB (%)
Total TSA area	**9,868,067**	**9,868,067**		
Land not managed by MOF (e.g.. private, woodlots, federal, Indian, military reserves)	29,927	29,927		
Area Managed by the MOF		**9,838,140**	**100.00**	
Reductions to TSA:				
Non-forest, non-productive, no typing	3,705,856	3,705,856	37.67	
Alpine (not previously accounted for)	3,006	3,006	0.03	
Non-commercial cover (brush)	350,671	350,671	3.56	
Existing roads, trails and landings	46,686	37,395	0.38	
Total productive Crown forest land base (CFLB)		**5,741,212**	58.36	**100**
Parks, UREPs and Ecological Reserves	1,059,861	371,322	3.77	6.47
NSR from wildfire, non-productive or misclassified	86,106	76,632	0.78	1.33
Non merchantable	301,193	250,253	2.54	4.36
Low timber productivity	4,416,007	2,729,564	27.74	47.54
Riparian reserve (stream, wetland and lake)	543,340	190,667	1.94	3.32
Environmentally sensitive areas	708,018	122,878	1.25	2.14
Unstable terrain	19,112	9,197	0.09	0.16
Wildlife range burn areas	354,999	27,109	0.28	0.47
Stand-level biodiversity (existing wildlife tree patches)	434	367	0.00	0.01
Seismic areas	111,957	26,026	0.26	0.45
Inoperable areas	7,419,049	361,670	3.68	6.30
Black spruce leading stands	1,215,896	143,258	1.46	2.50
Total Reductions to the CFLB:		**4,308,943**	43.80	**75.05**
Current Timber Harvesting Land Base		**1,432,269**	14.56	**24.95**
Future Reductions:				
Future roads, trails and landing		29,825	0.30	0.52
Future stand-level biodiversity (WTP)		6,272	0.06	0.11
Future Timber Harvesting Land Base		**1,396,172**	**14.15**	**24.32**

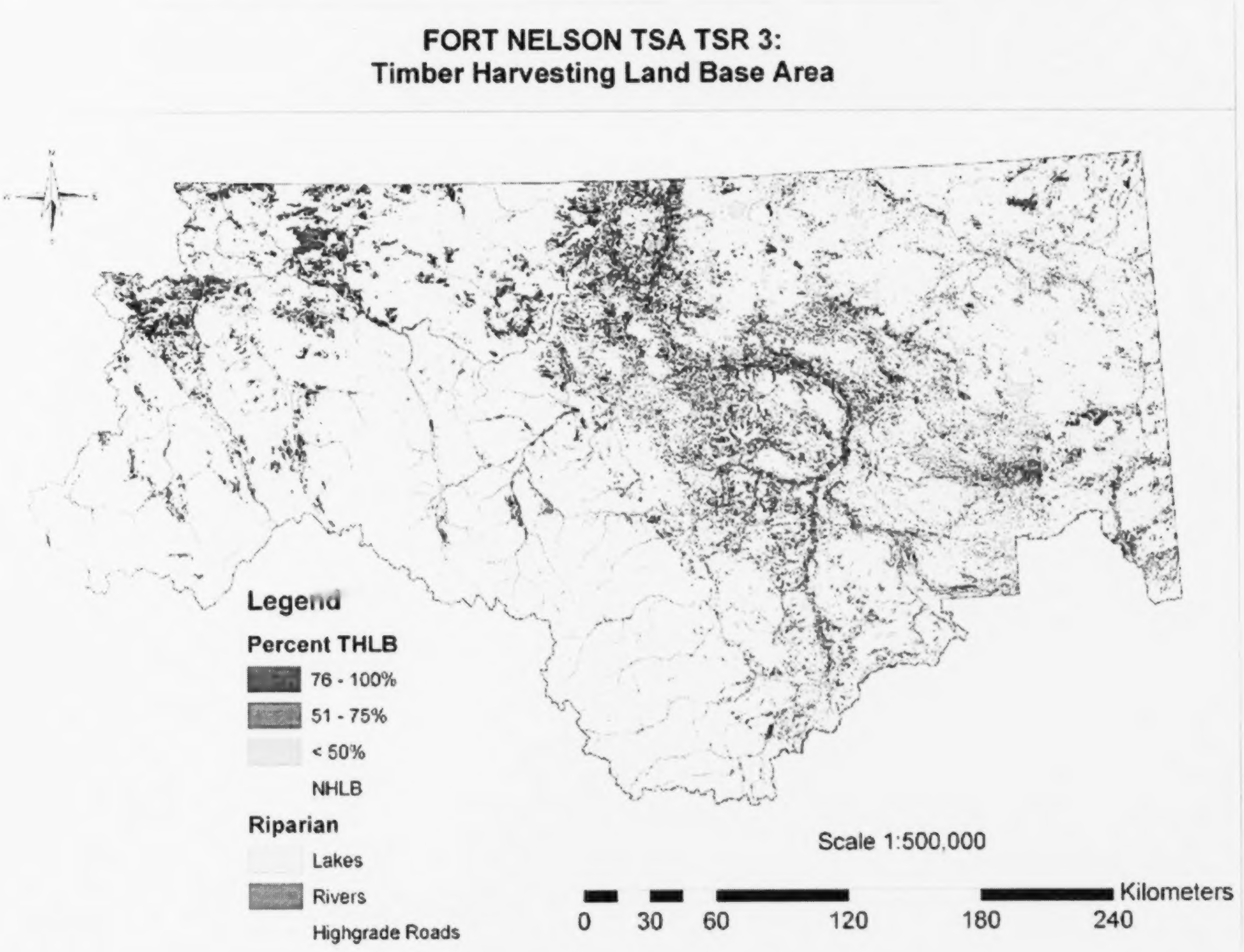
FORT NELSON TSA TSR 3:
Timber Harvesting Land Base Area
Legend
Percent THLB
76 - 100%
51 - 75%
< 50%
NHLB
Riparian
Lakes
Rivers
Highgrade Roads
Scale 1:500,000
0
30
60
120
180
240
Kilometers

Figure 3: Map of the timber harvesting land base in the Fort Nelson TSA

3.1.1 Current land base description of the TSA

The Fort Nelson TSA contains a large portion (42%) of non-productive, non-forest and/or non-Crown land as shown in Figure 4. The remaining 58% of the land base is considered productive forest with only a quarter classified as THLB. The productive area chart in Figure 4 details the categories of forest land and illustrates that the most significant reasons that areas are unavailable for harvest is low timber growth potential, which account for 47.5% of the forest land base.

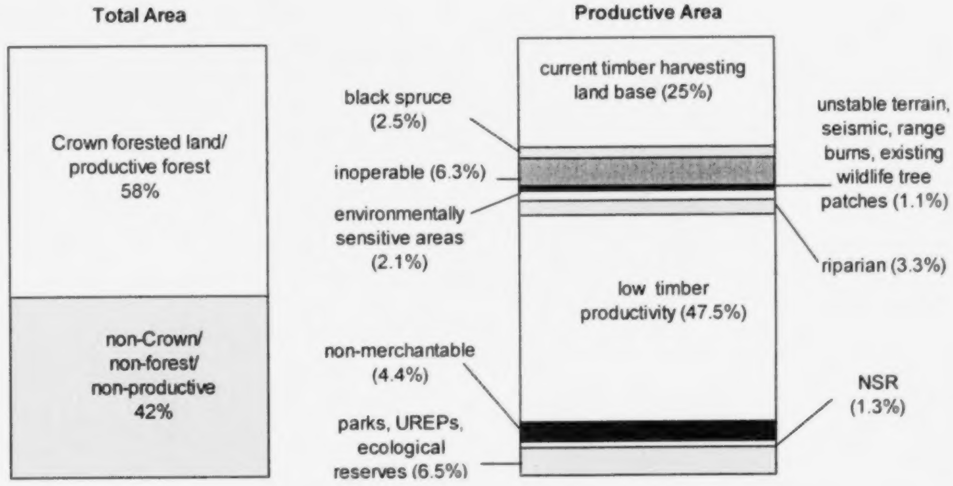

Figure 4: Composition of the total and productive forested land bases in the Fort Nelson TSA

The current composition of the THLB by dominant tree species and the proportion of area of each species that is either younger or older than the applicable minimum harvestable age (MHA)[3] is shown in Figure 5. The majority of the stands in the TSA are dominated by aspen , which cover about 40% of the THLB, while spruce dominates in about 33% of the THLB. Pine, cottonwood, and balsam dominate in 23.5%, 3%, and 0.5% of the THLB area, respectively.

The large amount of aspen and spruce in the Fort Nelson TSA contributes to the majority of the harvest volume in the TSA. Between 2000-2004, of the species harvested, approximately 50% were from aspen, 38% from spruce, 8% from cottonwood, 2% from pine, 1% from birch and 1% from balsam[4].

In total, about 71% of the THLB is currently at or above the MHA, while an additional 11% will reach MHA within the next 10 years. There is some variation in the current proportion above MHA amongst species groups: 85% of pine stands, 74% of cottonwood stands, 67% of aspen and spruce stands, and 58% of balsam stands are currently older than the MHA.

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[3] The minimum harvest age is discussed in detailed in the data package (Appendix 3, Section 19.1).

[4] Data represents the harvest volume billed from the MoF's Harvest Billing System.

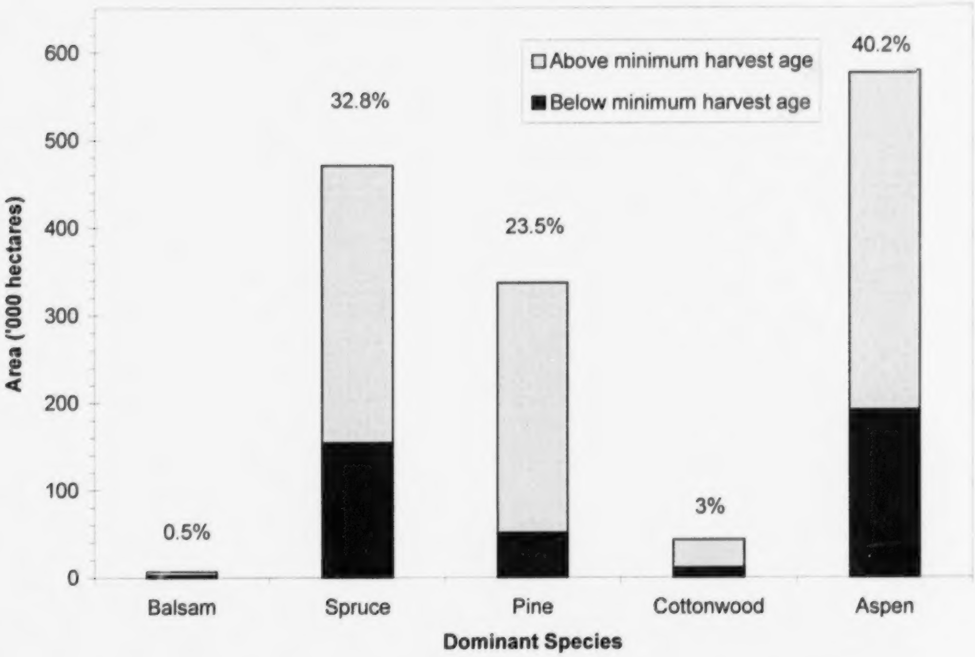

Figure 5: Area by dominant species in the Fort Nelson TSA timber harvesting land base

The distributions of site productivity within the THLB and NHLB by leading species are shown in Figure 6 and Figure 7, respectively. Stands classified as having low productivity are not currently considered economical to harvest and are excluded from the THLB. The site index* threshold for each species is listed in the data package (Appendix 4, Section 14.2). The THLB covers about one-quarter of the total forested area, and on average consists of the more productive sites within the TSA. In the future, if the cost of harvesting stands decreases or product selling price increases, stands with lower site productivity could be considered merchantable and would be included in the THLB. If this were to occur, the size of the THLB could increase significantly.

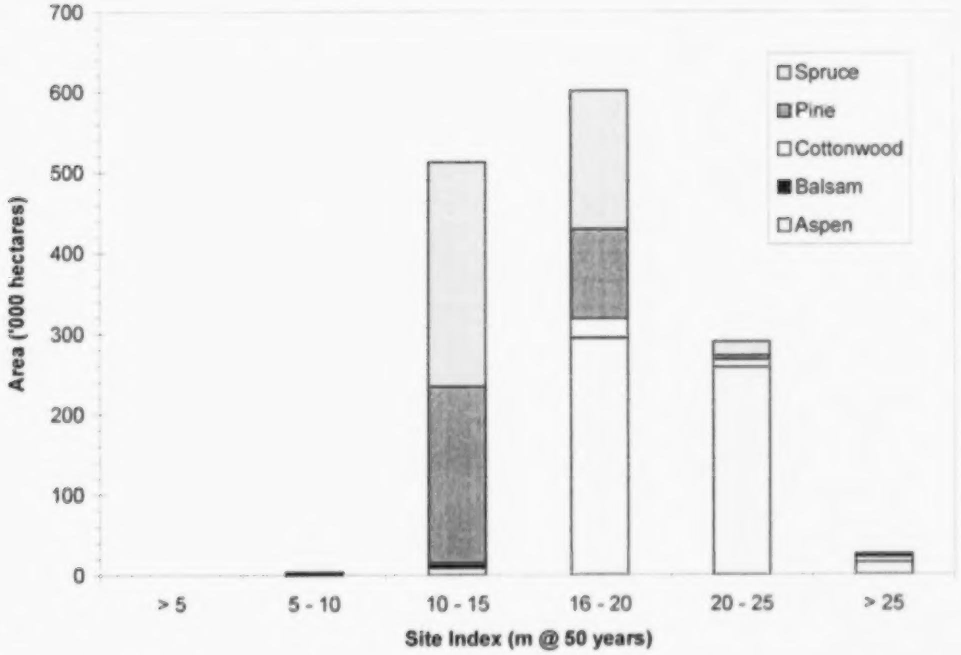

Figure 6: Site productivity by leading species in the Fort Nelson TSA timber harvesting land base

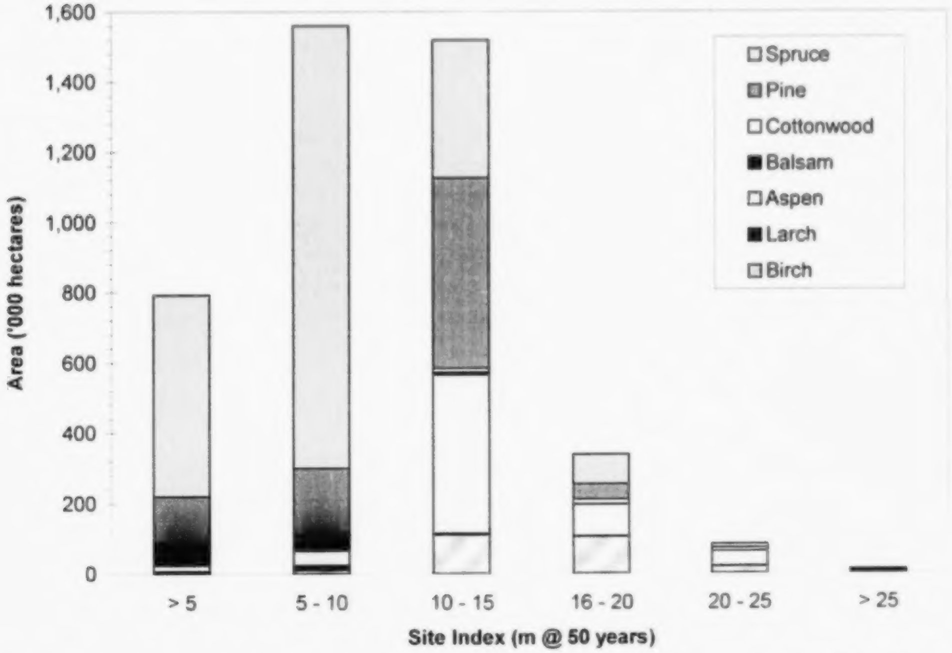

Figure 7: Site productivity by leading species in the forested area excluded from the Fort Nelson TSA timber harvesting land base (note change of scale from previous graph)

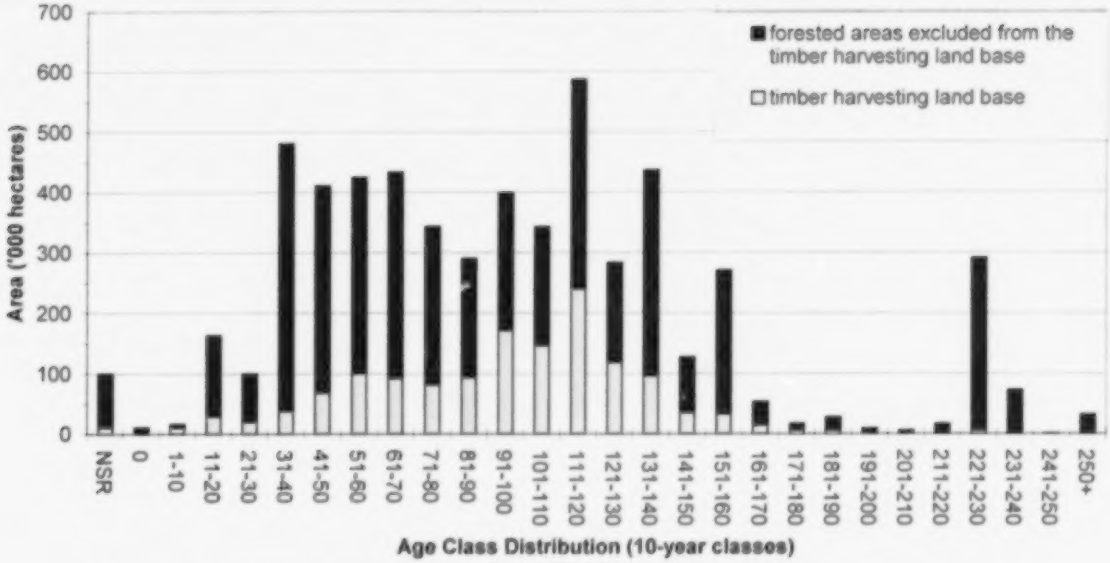

Figure 8: Current age class distribution in the Fort Nelson TSA productive forest land base

Currently, 84% of the forests in the CFLB are between 31 and 160 years old (Figure 8). The age class structure has been classified into the THLB and NHLB. Because the NHLB comprises approximately 75% of the CFLB, most of the area in each age class is from the NHLB, particularly in those stands older than 160 years. Although the NHLB is not harvested, it may influence timber supply through its contributions to non-timber objectives, such as old-forest attributes. Within the NHLB, about 14% of the stands are in old seral stage*, 31% in mature seral stage*, and 12% in early seral stage*. Within the THLB, a substantial portion of stands are also in mature (36%) or old (24%) seral stages* with approximately 5% is in early seral stages.

There are 100,382 hectares of current and backlog not satisfactorily restocked (NSR*) stands in the CFLB of which, 10,962 hectares are in the THLB. The 8,095 hectares of current NSR* in the THLB will be regenerated based on current management assumptions and the remaining 2,866 hectares of backlog NSR* is assumed to have a regeneration delay of 10 years.

3.2 Forest Dynamics

Forest dynamics refers to how the forest changes over time. In this section, the assumptions on how forests grow and age over time and respond to natural disturbance will be discussed.

3.2.1 Timber growth and yield

Timber growth and yield refers to the prediction of the growth and development of forest stands over time. Forest stands have many characteristics that change over time (for example, number of trees per hectare, tree diameter, tree height, and species composition). Since timber supply analysis concentrates on timber volumes available over time, the most relevant measure for this analysis is volume per area (cubic metres per hectare). An estimate of timber volume in a stand assumes a specific utilization level, or set of criteria, that establish the minimum tree and log sizes that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree.

Two growth and yield models were used to estimate timber volumes for the Fort Nelson TSA analysis. The variable density yield prediction (VDYP) model was used for estimating volumes in existing stands originating from natural regeneration (e.g. all conifer, deciduous and mixedwood stands). VDYP was also used for estimated volumes for stands regenerating to deciduous-leading, or mixedwood stands after harvest. The table interpolation program for stand yields (TIPSY) was used to estimate yields for conifer-leading managed stands. All pure spruce, spruce/pine, and pure pine stands are assumed to grow according to managed stand yield estimates from TIPSY if they were harvested since 1990 and onwards. The VDYP model was developed by the Resources Inventory Branch and TIPSY was developed by the Research Branch at the Ministry of Forests.

Uncertainty in volume estimation and prediction can occur due to ambiguous inventory data or assumptions made in growth and yield models, which form the basis for estimating site productivity. Sensitivity analyses described in Section 5.5 explore the possibility that actual timber volumes may be different from the estimates used in this analysis and the impact on the harvest level.

Based on timber volume estimates for existing stands, the current timber inventory on the THLB is approximately 149.7 million cubic metres for coniferous-leading stands and 130.1 million cubic metres for deciduous-leading stands. About 131.8 million cubic metres of coniferous-leading stands, and 113.6 million cubic metres of deciduous-leading stands are considered merchantable; that is, older than the minimum harvestable age and meeting the existing utilization standards.

3.3 Natural Disturbances

Natural disturbance mechanisms such as fire, insects, disease, and wind activities are continuous and often seasonal occurrences throughout the Fort Nelson TSA. These events can occur as small, common events (some types of disease pathogens) as well as extreme, significant events (catastrophic fire) either at the stand and landscape level.

In the Fort Nelson TSA, the modelling of natural disturbance was considered in the following ways:

1) **As a reduction to the harvested volume forecast as defined by non-recoverable losses** – historically these disturbances have occurred over a period of time (5 or 10 years). The estimate of the volume that is not salvaged or recovered following the disturbance is applied as an annual average volume reduction to the harvest forecast. This reduction of 106,355 m^3/year in the TSA addresses the volume loss associated with significant natural disturbance events (Appendix 4, Section 17)
2) **As a reduction to each stand to account for small disturbances** – small stand-level disturbances occur within a given stand type. These can be linked to analysis units and the corresponding yield curves. These reductions are typically applied in the development of the

yield curves and account for a stand level reduction associated with the disturbance that is expected to occur.

3) **By applying a "disturbance" to all stands within the non-harvestable land base** –the non-harvesting land base, which is not influenced by operational forestry will eventually be subjected to a disturbance and mortality. Based on the principles in the *Landscape Unit Planning Guide*, the stand age at which stands have likely experienced at least one natural disturbance is determined for each biogeographic unit. These stand ages (or disturbance age) range from 119 years for deciduous stands in the Boreal White and Black Spruce zone to 280 years for stands in the Spruce Willow Birch zone. For the base case, in the non-harvesting land base, when a stand reaches its disturbance age, it is assumed that its volume has been lost and it will be reset to age zero and start its development again. Refer to Appendix 4, Section 19.5 for more details regarding these assumptions.

Historic range burn areas (e.g. pre-1999) were excluded from the timber harvesting land base. No new range burn areas have been modelled. Most range burning in the Fort Nelson TSA is conducted to maintain current grasslands; however, very little to no burning of forests or non-grassland is done to convert areas to grass or range production. Almost all of the range burning in the TSA occurs within the Muskwa-Kechika management area. The impact of range burning is expected to be negligible.

3.4 Management Practices

How the forest is currently managed for both timber and non-timber values is one of many factors determining available timber supply. Therefore, the assumptions of current management practices must be defined and are often presented in three categories: integrated resource management assumptions, silviculture assumptions, and harvesting assumptions.

3.4.1 Integrated resource management

Non-timber values are generally managed by excluding areas from harvest or by applying forest cover constraints or objectives depending on the modelling methodology. For example, areas identified with high wildlife sensitivity or significant caribou or mountain goat habitat (ESA_W1 or ESA_W2) have been excluded from harvest in this analyses. Forest cover constraints have also been applied to manage for visual quality and landscape-level biodiversity.

Maintaining visual quality requires that visible evidence of harvesting be kept within acceptable disturbance limits. There is a total of 807,877 hectares (ha) in the TSA that have visual quality objectives (VQO), of which 603,692 hectares are in the CFLB. A map illustrating those areas of visual sensitivity with VQOs in the Fort Nelson TSA is provided in Appendix 10. Partial retention VQOs comprise the majority of the visually sensitive forest (434,812 ha in the CFLB) and this classification allows at most, 12.5% of each visual quality polygon to contain stands less than the visually effective green-up height (VEG height*). The calculated VEG heights for the Fort Nelson TSA range from 3 to 8.5 metres with the TSA average at about 3.8 metres. The remainder of the visually sensitive area is classified as preservation (1,755 ha), retention (34,643 ha), modification (115,681 ha) and maximum modification (16,801 ha), where at most 0.75%, 4%, 22.5% and 36.3% respectively, of the visually sensitive area within a visual quality polygon may be covered by stands less than the VEG height. About 12.2% (175,005 ha) of the visually sensitive forest occurs within the THLB.

To maintain biological diversity at the landscape level*, a proportion of the forested area within each biogeoclimatic variant* in each landscape unit must be covered by stands with mature plus old-, or old-forest characteristics. Mature ages (defined as 80 years or 100 years in the Fort Nelson TSA), old ages (100, 140 or 250 years), and the proportion of area required in mature and old conditions depend on the natural disturbance type (NDT)*, biogeoclimatic zone and variant and the designated biodiversity* emphasis.

3.4.2 Silviculture

Silviculture practices include the reforestation activities required to establish free-growing* stands of acceptable tree species. Based on current practices within the Fort Nelson TSA, all coniferous stands (40.5% of the THLB) are assumed to be planted to spruce and/or pine, depending on site conditions while all mixedwood and deciduous stands (30% and 29.5% of the THLB, respectively) are expected to naturally regenerate to pre-harvest species compositions.

3.4.3 Harvesting

Current assumptions regarding harvesting have been modelled and include:

- **Unsalvaged losses***—timber losses to fire, insects and diseases are expected to average 106, 355 m^3/year in the THLB,
- **Utilization levels**—minimum sizes of trees, and logs to be removed during harvesting.
- **Cutblock adjacency* and green-up**—within the THLB for the Fort Nelson TSA, the integrated resource management (IRM) area is defined as area that is not subject to visual quality objectives. Within the IRM, approval of harvesting activities is contingent on previously harvested stands reaching a desired height condition, or "green-up" (three metres in height), before adjacent stands may be harvested. Furthermore, the area in the THLB that does not meet green-up conditions cannot exceed 39% in each of the 85 landscape units. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated within a specific geographic area at any given time.
- **Minimum harvestable ages** — the time required for stands to grow to a merchantable condition. Minimum harvestable ages for this analysis were set at the age at which stands reach a minimum volume of 140 m^3/ha. The minimum harvestable age defines the youngest age at which a specific type of stand is expected to become harvestable. Actual harvest age may not be less than the minimum, and will depend on ages of other stands, forest cover objectives* (e.g., for adjacency, old growth and visual quality), and overall timber harvest targets

More detailed descriptions of these management practices and modelling assumptions are provided in the data package (Appendix 4).

3.5 Timber Supply Analysis Methods

The purpose of this analysis is to examine the timber harvesting opportunities in the Fort Nelson TSA under current forest management practices. A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in generating harvest forecasts (supply of timber over time) using a set of forest management assumptions. The model uses information about the THLB, timber volumes, and the management regime to represent how forests grow and are harvested over hundreds of years.

Forest Simulation and Optimization System (FSOS) is the timber supply computer simulation model used for this analysis, which was developed by Dr. Guoliang Liu. The model can be operated at a forest or landscape-level, with spatial or non-spatial methods, and with simulation or heuristic techniques. FSOS has been used on over 27 forest management units (TFLs and TSAs) throughout BC, Alberta, Manitoba and Ontario. The model has been accepted for use in timber supply analysis by the chief forester of British Columbia in previous analyses.

The modelling for each scenario was conducted over a 550-year period but only the results for the first 250 years are shown in this report because the projected harvest remains constant after that time. There is no presumption that forest conditions hundreds of years in the future can be accurately predicted with a computer model; however, the long analysis horizon is provided in recognition of the fact that forest-level changes often occur over very long time periods.

Similar to other forest estate models, FSOS assumes that trees grow according to specified yield projections and are harvested according to either a volume target or a specified objective (such as harvest volume maximization) set by the analyst. FSOS also allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of cutblock adjacencies and green-up prescriptions. For example, guidelines might specify that no more than a maximum percentage of the forest can be younger than a specified green-up age, or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat. FSOS facilitates examination of the effects of such guidelines on timber supply.

The results of the analysis are important in determining harvest forecasts that will not restrict future options of resource managers, and that will assist local Ministry of Forests and Range staff to administer their programs according to relevant guidelines and principles. The results of the analysis represents possible future timber supplies and are not meant to be taken as recommendations of any particular AAC, but to support rather than hinder sustainable forest management in the TSA.

3.6 Differences Between TSR 2 and TSR 3

Since the last timber supply analysis (TSR 2), changes have been made to the input data, inventory, assumptions made in defining the THLB, representation of current management, and the modeling algorithm and methodology. A summary of the differences in assumptions between TSR 3 and TSR 2 and their estimated impact on the harvest level is shown Table 6.

Table 6: Major differences in assumptions between TSR 3 and TSR 2

Item	TSR 3	TSR 2	Impact on projected harvest
Total Area	9,868,067 ha	8,213,731 ha	A total area of 1.5 million ha of the Cassiar Addition has been added to the TSA. Positive impact. Total area is increased by 23%.
CFLB	5,741,212 ha	4,190,550 ha	Positive impact. CFLB is increased by 37%.
THLB	1,432,269 ha	924,857 ha	Positive impact. THLB is increased by 55%.
Cassiar Addition	Is included in the TSA and analysis	Is not included in the TSA but a sensitivity analysis that excludes this area from the THLB was completed.	Positive impact. The Cassiar Addition contributes 180,869 ha to the THLB.
Inventory	New VRI Phase I photo interpreted inventory and adjustment factors derived from VRI Phase II ground sample data for approx. one-third of the TSA	FC1/FIP inventory	Likely a positive impact. Improved species, SI, and volume information.
Operability	Based on an assessment of stand quality, harvest method and available land base	Based on a delivered wood cost assessment	Likely a negative impact because of the greater inoperable area found through TSR 3.
Modelling Approach	One harvest target modelled by combining coniferous and deciduous volume.	Two separate harvest flows based on groupings of conifer-leading and deciduous-leading stands	Likely positive due to a larger contiguous land base and increased flexibility.
Genetic gain	3% genetic gain for pine in current and future managed stands	No genetic gain considered	Positive in the long term. There are 290,700 ha in pine analysis units or 20% of the THLB.
Regeneration delay	1 year regeneration delay for deciduous-leading unmanaged stands. 1 year regeneration delay for future managed spruce stands.	2 year regeneration delay for deciduous-leading unmanaged stands. 4 year regeneration delay for future managed spruce stands.	Positive in the long term.
Immature aspen stands	The minimum SI used to define unproductive immature aspen stands was 15.9 m.	The minimum SI used to define unproductive immature aspen stands was 17.7 m.	Positive impact because 76,761 ha of immature aspen stands (whose SI were between 15.9 and 17.7 m) were included in the THLB.
Mature small	Mature pine-leading stands	All pine stands regardless	Positive impact. There are 180,869

Item	TSR 3	TSR 2	Impact on projected harvest
pine stands	that were ≥ 81 years, with stand heights ≥ 16 m, and with stand volume ≥ 140 m^3/ha were included in the THLB.	of age with SI ≥ 16.4 m were included in the THLB. Heights (≥ 20), volume (≥ 140 m^3/ha) and age (≥ 81 years) were used to determine the SI.	ha of mature pine stands between 16-20 m in height.
Natural disturbance in the NHLB	Applied	Not applied	Negative impact.
Unsalvaged loss	106,355 m^3/year	63,766 m^3/year	Negative impact on harvest flow due to more unsalvaged losses.
Rehabilitation of non-commercial brush	Not applied	250 ha of spruce added to the THLB each year for the first 10 years	Small negative impact to the THLB.
Non-commercial brush reductions	Non-commercial brush is not part of the crown forested land base.	Non-commercial brush is part of the crown forested land base.	Likely no impact.
Unstable terrain	Areas identified as unstable terrain through reconnaissance mapping were excluded from the THLB.	No terrain reconnaissance mapping available.	Negative impact: 9,197 ha removed from the THLB.
Riparian Reductions	Methodology based on stream order	Methodology based on analysis of 10 map sheets.	Likely a small negative impact because a higher percentage of streams in the CFLB was found in TSR 3 (3.3% in TSR 3 vs. 2.5% in TSR 2).
Roads, trails, landings (RTL) and oil and gas	New seismic and road spatial data. RTL are not part of the crown forested land base.	Spatial seismic data. Road reductions applied to areas ≤ 40 years. RTL are part of the crown forested land base.	Negative impact. More roads and seismic areas in TSR 3.
Visual Quality Objectives	VQOs established in 1997 along the Alaska Hwy and Klua Lakes and VQOs in the Cassiar Addition are included.	VQOs established in 1997 along the Alaska Hwy and those in the Cassiar Addition are not included in the analysis.	Negative impact because additional forest cover constraints will be applied to the THLB. VQOs in TSR 2: 358,341 ha in the CFLB and 116,923 ha in the THLB. VQOs in TSR 3: 603,692 ha in the CFLB and 175,005 ha in the THLB. A difference of 58,082 ha of additional VQOs in the THLB for TSR 3.
Visually effective green-up	VEG height differs by VQO polygon but the TSA average is 3.8m.	VEG height of 5m is applied to each VQO polygon.	Positive impact.
Future stand-level biodiversity (WTP)	Reductions were to the current timber harvesting land base.	Reductions were made to the future timber harvesting land base.	Likely no impact (possible small negative impact in the short-term).

Item	TSR 3	TSR 2	Impact on projected harvest
Total WTPs (existing and future)	6,706 ha	68,536 ha	Different assumptions and methodology. Possibly a positive impact.
Old, Old+Mature Seral Targets	Targets were modeled based on the assumption of established BEO.	45/45/10 rule was applied to L, I, and H BEO.	Likely no impact.
Sites with low growing potential	Site index threshold was applied to immature stands; and height and volume criteria were applied to mature stands.	Site index threshold was applied to both immature and mature stands	THLB increase of 86,952 ha over the TSR 2.

4 Base Case Analysis

This section presents the base case harvest forecast and its supporting diagnostic summaries for the Fort Nelson timber supply area. The base case forecast is the timber supply forecast, which illustrates the effect of current forest management practices on the timber supply using the best available information. The base case also forms the reference point for sensitivity analysis. The sensitivity analyses are provided in Section 5.

4.1 Base Case Harvest Forecast

This timber supply did not use a separate harvest flow for coniferous and deciduous species groups, as in the previous timber supply analysis for the Fort Nelson TSA (TSR 2). Rather, the conifer-leading stands and deciduous-leading stands were combined to project one overall harvest forecast. In TSR 2, all the species including the volume in minor components of stands were included in the species group volume. For example, if the stand was a mixedwood stand with 51% conifer and 49% deciduous, the entire volume of this stand would be included in the coniferous harvest volume. This modification was selected as the previous approach did not reflect operational reality since the licencees report each species component in a stand as coniferous or deciduous volume regardless of whether the species component came from a conifer-leading or deciduous-leading stand. Furthermore, there are also some concerns with misrepresentating mixedwood stand dynamics when they are grouped with pure conifer or pure deciduous stands. The TSR 3 method is thought to be an improvement over TSR 2; however, it does allow for temporal fluctuations in conifer and deciduous harvest levels, which may be resolved by averaging the species grouping harvest over a period of time. In this analysis, harvest volumes are reported for the coniferous and deciduous components in a stand and are the averages over a 250 years forecast horizon. Please see Section 3.6 for further details on the difference between TSR 3 and TSR 2.

Unsalvaged losses due to natural disturbances, estimated to be 106,355 m^3/year, have been subtracted from all harvest forecasts presented in this report. More details on the calculation of unsalvaged losses can be found in the data package (Section 17 in Appendix 4).

The base case harvest forecast is 3,163,000 m^3/year of which the average harvest of 1,719,500 m^3/year comes from coniferous species and 1,443,500 m^3/year comes from deciduous species (Figure 9). As a reference point, the current allowable annual cut is 1,500,000 m^3/year, which comprises of 900,000 m^3/year from deciduous-leading stands and 600,000 m^3/year from coniferous-leading stands. In the base case harvest forecast, the harvest volume from conifer and deciduous species fluctuates over time, as illustrated in Figure 9,

For the first 35 years, the majority of the harvest comes from deciduous stands. The reasons are likely related to the relative oldest first harvest rule applied in the analysis and forest cover constraints applied to the land base. The relative oldest first harvest rule assumes that the stands are prioritized for harvest based on a ranking derived from the difference between the stand age and minimum harvest age (MHA)*, where essentially older stands are harvested first. Both the conifer-leading and deciduous-leading land bases contain a significant amount of area above MHA (74% and 67%, respectively). In the short-term, it is also possible to have a majority conifer harvest

(Section 5.2, alternative flow 1) suggesting that there is enough growing stock in the land base for such flexibility in targeting harvest from the conifer and deciduous groups.

The criteria used when determining the base case include maintaining a constant growing stock level over the long term, and avoiding any large and abrupt timber supply shortfalls. The first criterion is an indicator of long-term sustainability, while avoiding excessive timber supply fluctuations provides for socio-economic stability and helps to maintain future options.

The Fort Nelson TSA is not a very constrained TSA with only about 12% of the timber harvesting landbase (THLB) overlapping with other forest values, such as visual quality objectives. Theoretically, if all stands were harvested at the age of maximum productivity and without considerations to non-timber values, an average annual harvest rate of approximately 3,643,441 m^3/year could be achieved in the long term. However, the base case long-term harvest level is 13.2% lower than this theoretical maximum productive capacity of the THLB. The maximum is not achieved because visual quality objectives; maximum disturbance limits within landscape units; the impact of natural disturbance in the non-harvesting land base on the overall seral and visual objectives on the forested land base; the relative oldest first harvest rule; and the objective of maintaining an even harvest flow over time result in stands not being harvested at the time of maximum productivity.

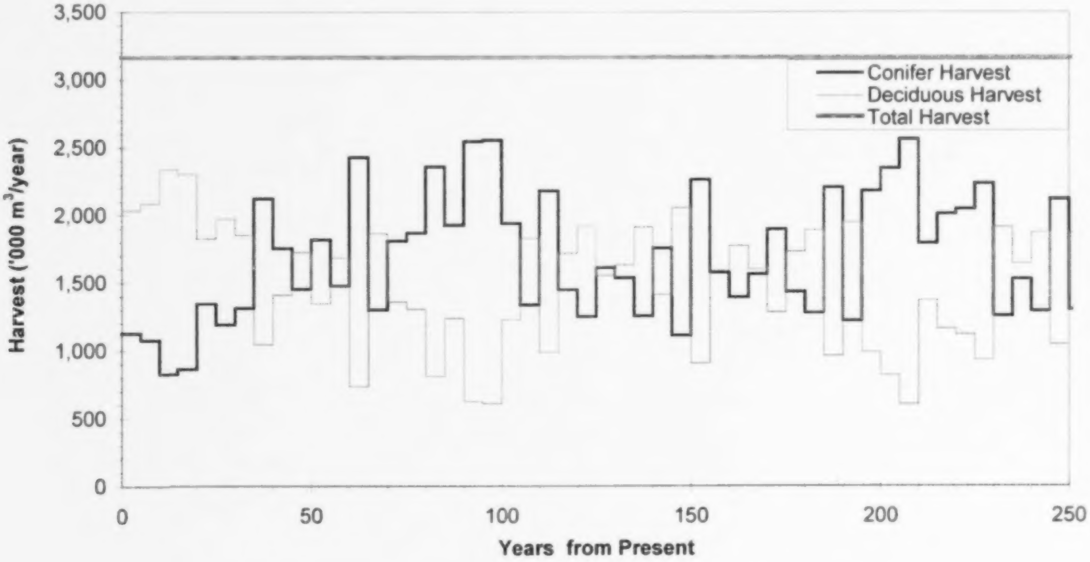

Figure 9: Current base case harvest forecast for the Fort Nelson TSA

4.2 Base Case Growing Stock

The total growing stock for the base case in the Fort Nelson TSA is presented in Figure 10 and Figure 11. The growing stock figures are for a 550-year period to demonstrate a stable yet slightly fluctuating long-term growing stock where the model will accumulate more growing stock after the event of relatively large natural disturbances (mainly 10, 55, 125, 340 and 430 years from present) to meet mature and old seral targets and visual quality objectives. The average growing stock figures provided below (and all other figures in this report) are averaged over a 250-year period.

The current total growing stock is approximately 278.6 million m^3 and declines over 155 years before stabilizing at around 194.2 million m^3. For the first 155 years, the average growing stocks from conifer and deciduous trees are 132.9 million m^3 and 95.9 million m^3, respectively. After 155 years, there are 115.6 million m^3 and 78.6 million m^3 of growing stocks from conifer and deciduous trees, respectively. Most of the total growing stock (approximately 90%) is from merchantable stands suggesting that the harvest level is limited by forest cover constraints (i.e. old seral objectives) rather than the available merchantable growing stock[5]. The growing stock from non-merchantable stands remains fairly stable at around 19.9 million m^3.

On average, approximately 55% of the growing stock consists of coniferous trees and the remaining 45% from deciduous trees; this is representative of the THLB where 57% and 43% of the area is in pure or conifer-leading stands and pure or deciduous-leading stands, respectively (Figure 11). The mean annual increment projected over time is 2.28 m^3/ha/year. The mean annual increment is derived by dividing the long term harvest level (3,163,000 m^3/year), including unsalvaged losses (106,355 m^3/year) by the THLB (1,432,269 ha).

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[5] The total growing stock is the merchantable volume of all stands as defined by the species-specific utilization level and the non-merchantable growing stock. The merchantable growing stock is a subset of the total growing stock and contains the volume from those stands that are older than their specified minimum harvest age. The non-merchantable growing stock is the volume from stands that are in the THLB but have not met their specified minimum harvest age. The non-merchantable growing stock is essentially the area between the total and merchantable growing stock in Figure 10.

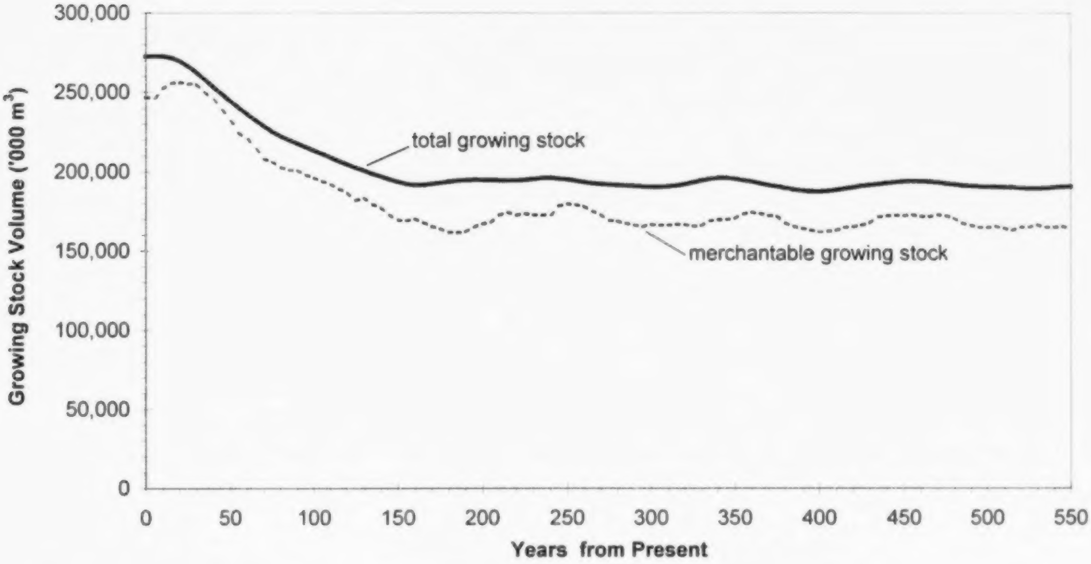

Figure 10: Growing stock ('000 m3) for total and merchantable stands over time for the Fort Nelson TSA base case

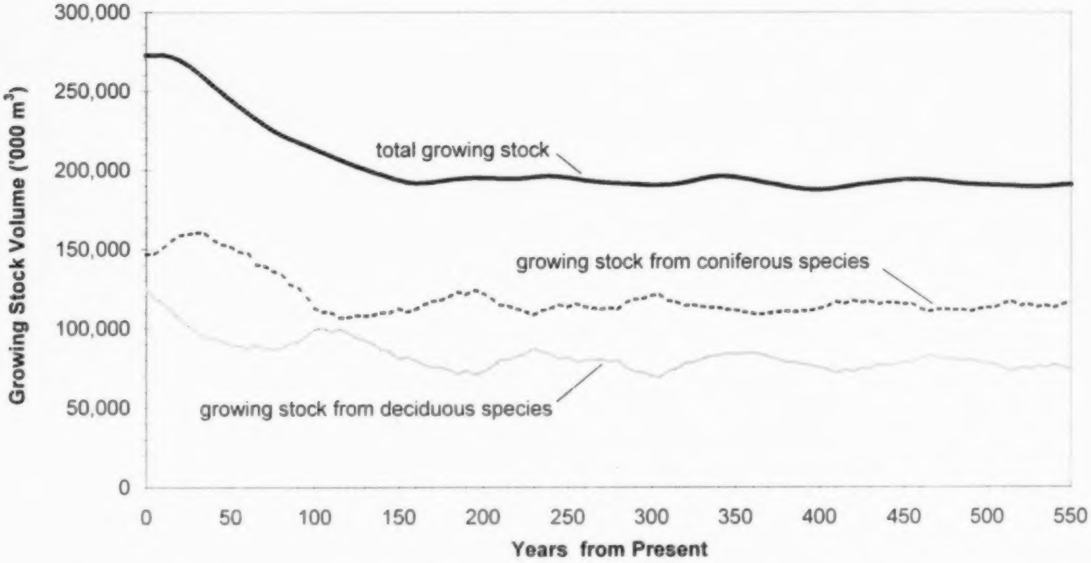

Figure 11: Growing stock ('000 m3) for coniferous and deciduous species over time for the Fort Nelson TSA base case

4.3 Base Case Attributes

An important factor defining timber supply is the timing of the transition of harvesting from existing natural, mostly older stands, to managed stands. This transition is modeled only in pure spruce, pine, and spruce/pine stands because of the lack of information on the growth of managed mixedwoods and pure deciduous stands. Growth in future mixedwoods and future pure deciduous stands is projected using a natural stand growth model. The contribution of natural (or unmanaged) stands as well as managed stands to the base case harvest forecast is shown in Figure 12. In the figure, spruce/pine stands are classified as future managed after their first harvest because of the planting required for stand regeneration after harvest. Analysis results indicate that timber supply will begin relying on spruce/pine regenerated stands approximately 100 years from now, with a significant amount of the harvest coming from regenerated stands by 130 years from now. The harvest from spruce/pine managed stands contribute 32% and 38% of the total harvest, as averaged over years 130-250 and years 130-550, respectively.

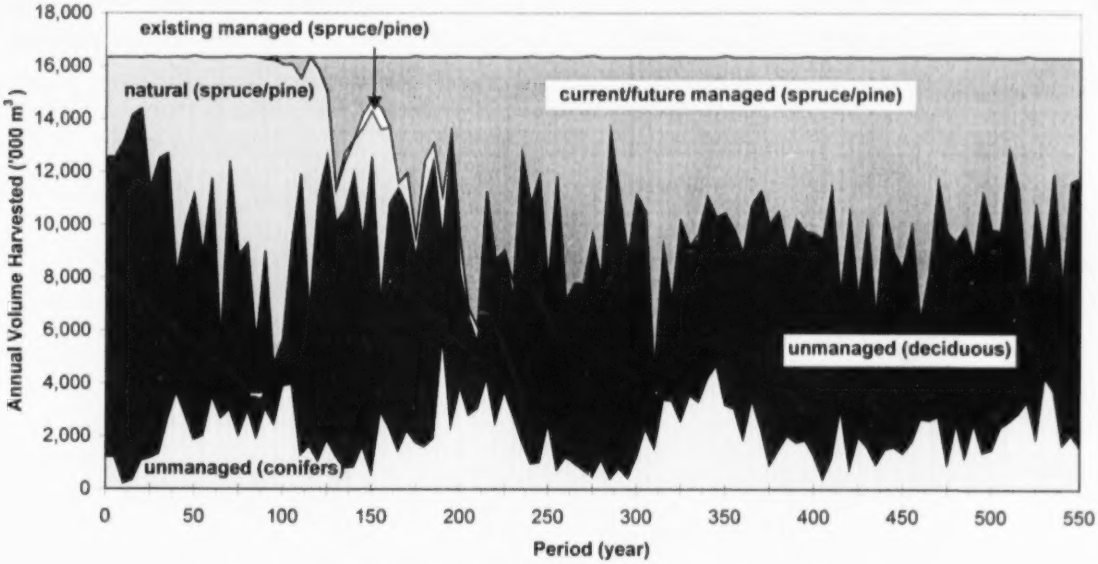

Figure 12: Contribution of unmanaged and managed stands to the harvest forecast

The annual area harvested over the next 250 years under the base case harvest forecast is shown in Figure 13. Even though the volume cut remains fairly constant over the planning horizon, the area harvested fluctuates slightly because over time the harvests are projected to come from stands of different species and age. Over the planning horizon, the area harvested fluctuates between 8,990 ha (which occurs 10 years from now) to 11,240 ha (which occurs 240 years from now). The average annual cut area is 10,224 ha, which is shown by the grey line in Figure 13. The area harvested is projected to decrease slightly from 10,360 hectares per year over the next 140 years to 10, 050 hectares per year from 140 to 250 years from now. The slight decrease can be attributed to the transition from unmanaged to managed stands of pure or mixed spruce and pine species, where the managed stands contain relatively more volume per hectare than their counterparts in unmanaged stands.

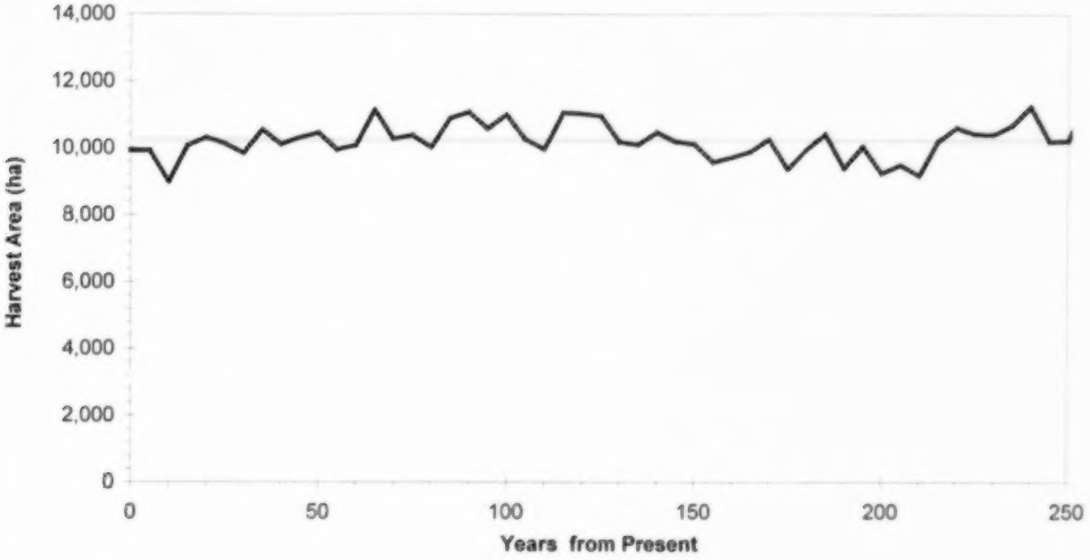

Figure 13: Area harvested over time in the Fort Nelson TSA base case

The average volume per hectare harvested over the same time period is 317 m^3/ha (as shown by the grey line in Figure 14). Over the planning horizon, the volume cut per hectare is the lowest at 284 m^3/ha in year 240 and the highest at 364 m^3/ha in year 10. The volume per hectare increases slightly over time with an average cut of 315 m^3/ha over the first 140 years to 320 m^3/ha from 140 to 250 years. Again it is assumed that the pure spruce and pine stands will realize significant volume gains upon regeneration as a result of management activities, and will grow according to managed stand yield tables. Refer to Section 16 in Appendix 4, for more details regarding regeneration assumptions used in this analysis.

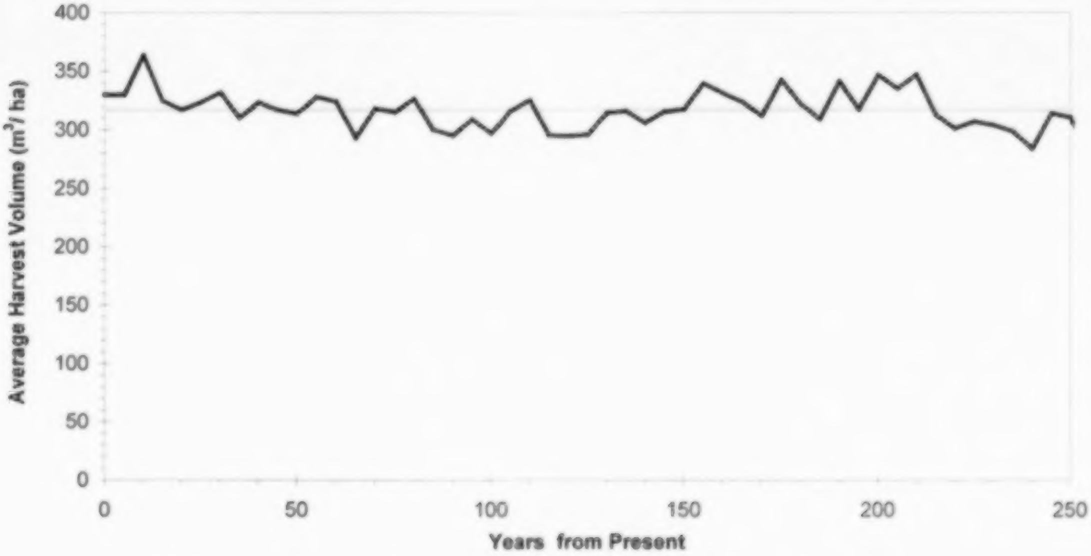

Figure 14: Average volume per hectare harvested over time in the Fort Nelson TSA base case

For the entire harvest forecast period few stands are harvested at the minimum harvest age due to the high proportion of older stands available for harvest, the higher harvest priority given to older stands, other resource objectives, and the objective of maintaining an even harvest flow over time. Over the 250 year planning horizon the average harvest age range from 119 years (at 195 years from now) to 220 years (at 115 years from now) (Figure 15). The average harvest age is 149 years over the entire 250 year planning horizon (as shown by the grey line in Figure 15. A general trend can be seen where the average harvest age (155 years over the first 140 years) is greater in the short and medium terms than in the long-term (142 years as averaged over 140 to 250 years from now). This again can be attributed to the transition to managed stands, which can achieve similar volumes as unmanaged stands at an earlier age. Due to deciduous stands maturing earlier than conifer stands (and as reflected by the younger minimum harvest ages in deciduous stands), the average harvest age is less in deciduous-leading stands (118 years averaged over a 250 year period) than in conifer-leading stands (150 years).

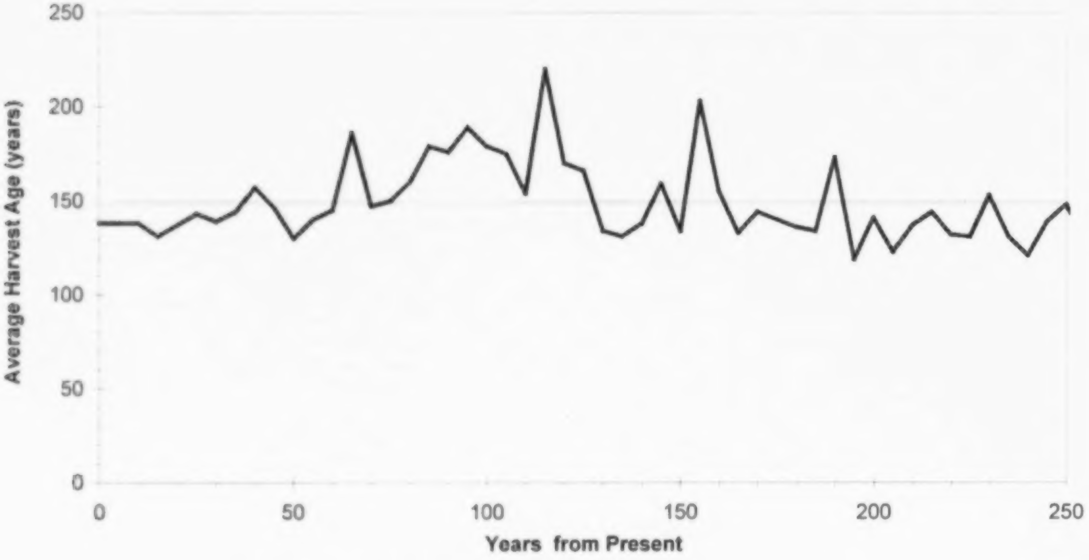

Figure 15: Average harvest age over time for the Fort Nelson base case

The age composition of the forested land base in the Fort Nelson TSA changes over time as shown in Figure 16 to Figure 21. Currently, 85% of the THLB is between 41 and 140 years old.

After 50 years, approximately 35% of the THLB has been harvested once. There is an even age class distribution in the 10-year age classes between 0 and 50 years (Figure 17). In addition, approximately 996,250 hectares (about 23%) of the NHLB have been converted to young stands by natural disturbance. The age class structure in the NHLB is partly a result of the succession assumptions that were applied in the analysis to the inoperable land base. For example, the stands in the Spruce Willow Birch BEC zone are 'naturally disturbed' when they reach 280 years of age. Conifer stands in the Boreal White and Black Spruce (BWBS) BEC zone go through succession at stand age of 161 years and deciduous stands in the BWBS go through succession at the stand age of 119 years.

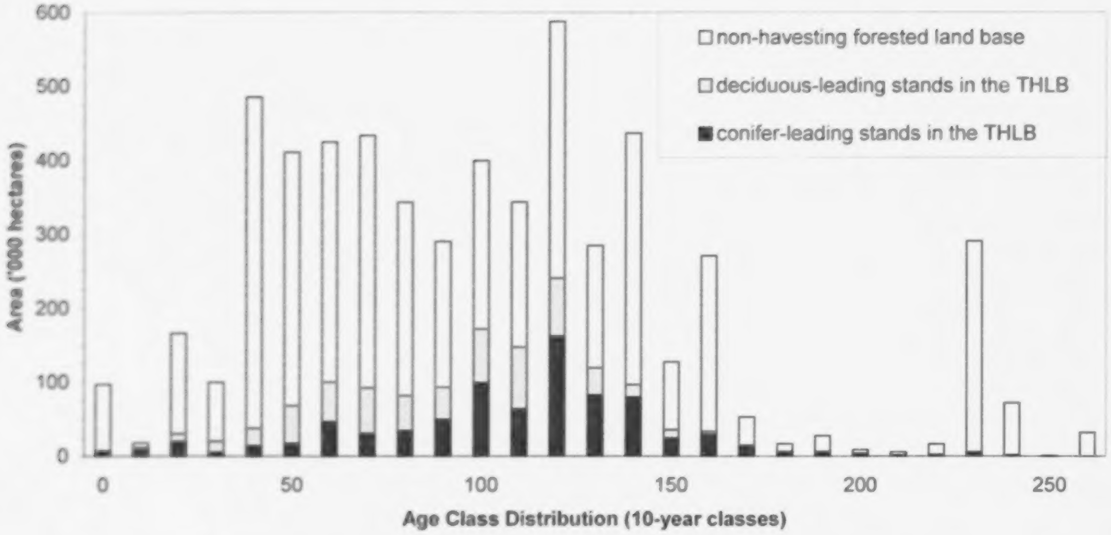

Figure 16: Current age class distribution in the forested land base in the Fort Nelson TSA

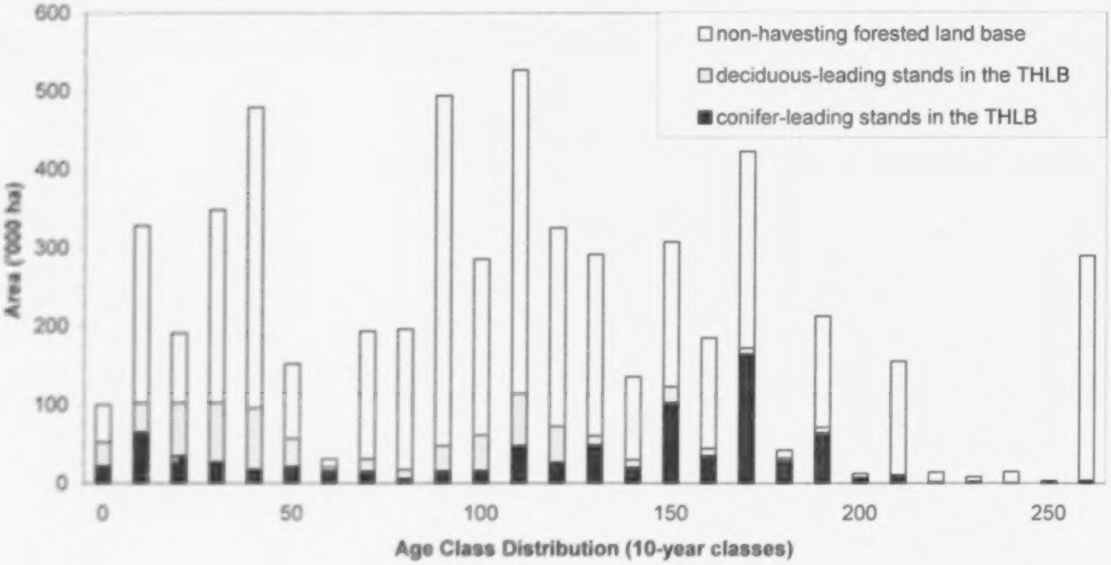

Figure 17: Forecasted age class distribution in the forested land base 50 years from present

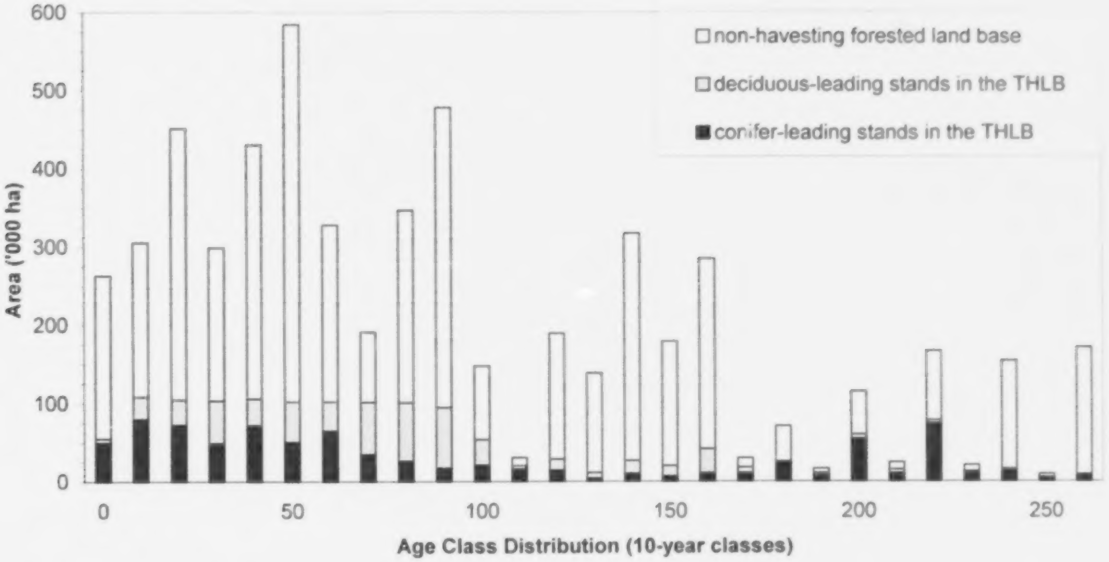

Figure 18: Forecasted age class distribution in the forested land base 100 years from present

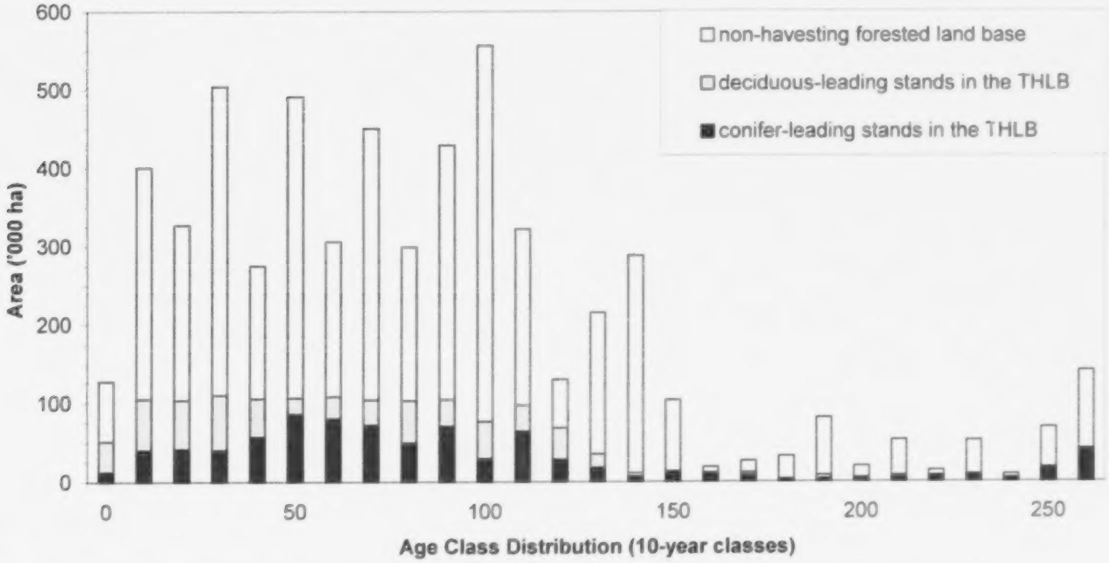

Figure 19: Forecasted age class distribution in the forested land base 150 years from present

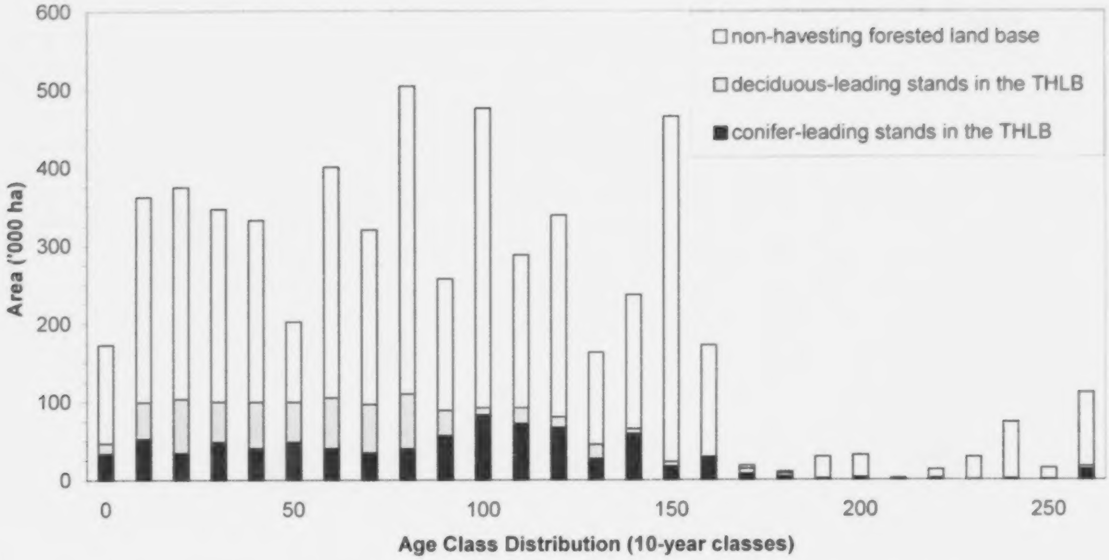

Figure 20: Forecasted age class distribution in the forested land base 200 years from present

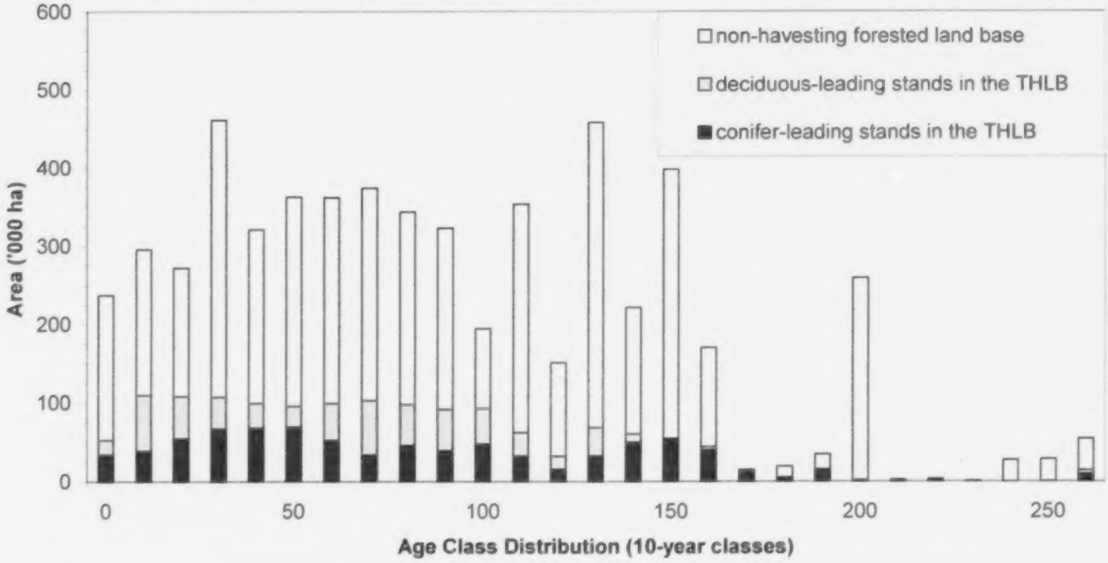

Figure 21: Forecasted age class distribution in the forested land base 250 years from present

Over time, the age class distribution in the THLB becomes relatively even-aged especially at age classes 1 through 100 years old. Generally the conifer-leading stands dominate the older stand age classes in the THLB. At 100 years, 72% of the THLB has been cut at least once and 63% of the NHLB has been disturbed at least once. By 150 years, the area disturbed increases to 91% and 89% of the THLB and NHLB, respectively.

Although the NHLB does not contribute to the harvest volume in the TSA, the assumptions around natural disturbance in the NHLB have a significant impact on achieving the overall forest cover objectives (e.g. old seral targets and visual quality objectives). Within a localized area (e.g. a landscape unit), if a large natural disturbance occurs in the NHLB resulting in forest cover objectives not being met, the forest estate model will retain stands in the THLB from harvesting until stands from the THLB and/or NHLB achieve the forest cover objectives.

4.4 Seral Targets in the Base Case

Canfor and BCTS will manage the land base to achieve old forest targets as outlined in the *Order Establishing Provincial Non-Spatial Old Growth Objectives* (MSRM, 2004) for all 85 landscape units (LUs). It should be noted that the Canfor and BCTS only operate in 23 of the 85 LUs. The licensees will also attempt to achieve the targets for mature forest as identified in the *Land Use Planning Guide*.

The provincial government has established seral targets for each landscape unit (LU)* and biogeoclimatic variant* (BEC) by Biodiversity Emphasis Option (BEO). These targets are applied to entire crown forested area (i.e. to both the THLB and NHLB). For more details regarding the seral targets by LU, BEC, and BEO, please refer to the data package (Appendix 4, Section 18.5).

Natural disturbance as modelled in the NHLB, the current age class structure and the harvest schedule affect the achievement and under-achievement of the seral targets. Of the 251 LU-BEC combinations, 139 (55%) currently meet the percent old seral targets while the remaining 112 (45%) do not (Table 7). For active areas in the THLB (BWBSdk2 and BWBS mw2), approximately 70% of the LU-BEC combinations are currently meeting the old seral target. Of the 187 LU-BEC combinations for mature plus old targets (note that there are no mature plus old targets for SWB), 157 (84%) currently meet the percent mature plus old targets (Table 7). For active areas in the THLB, approximately 85% of the LU-BEC combinations are currently meeting the mature plus old target.

Table 7: Percent of landscape unit-biogeoclimatic zones combinations that first met the old and mature plus old seral targets by the time period class

		Time Period the % Old and Mature+Old Target Were First Met							Total
BEC variant	**Seral Stage**	**0 years**	**1 - 5 years**	**6 - 10 years**	**11 - 20 years**	**21 - 35 years**	**36 - 50 years**	**50+ years**	**Number of LU-BEC**
BWBSdk 1	Old	82%	9%					9%	11
BWBSdk 2	Old	85%	6%					9%	33
BWBSmw 2	Old	66%	6%	2%	7%	11%	7%		122
BWBSwk 3	Old	24%	19%	5%	14%	19%	10%	10%	21
SWB mk	Old	17%				55%		28%	47
SWB mks	Old	47%				53%			17
BWBSdk 1	Mature+Old	82%	9%				9%		11
BWBSdk 2	Mature+Old	76%	3%			3%	6%	12%	33
BWBSmw 2	Mature+Old	88%	5%	1%	2%	5%			122
BWBSwk 3	Mature+Old	76%		5%	5%	5%	10%		21

To illustrate the use of this table, in the BWBS dk1, 82% of all the LU-BEC combinations that contain BWBSdk1 (or 9 out of the 11 LU-BEC combinations) currently meet the old seral targets. Nine percent of the BWBSdk1 LU-BEC will first meet the old seral targets, within the next five years and 9% will first meet the targets after 50 years.

Due to the large amount of area in the NHLB (4.3 million ha) when compared to the THLB (1.4 million ha), natural disturbance modelled in the NHLB plays a critical role in the overall percent of old forests in the Fort Nelson TSA. Over a 250-year forecast horizon, the percent of old forest can fluctuate (e.g. between 11% to 26% over the entire CFLB). The percent of mature plus old forest also fluctuates over time and has a range of 34% to 56%. These fluctuations are largely due to the effect of natural disturbance and to some extent harvesting. When old seral targets are met in the forested land base, any additional old forest can potentially be harvested by the model. However, the model does not predict or risk manage for future natural disturbances (i.e. it does not retain a reserve of old forests in the THLB in case natural disturbances occur in the NHLB).

The maintenance of old and mature plus old seral targets by LU-BEC area is shown in Table 8 and is provided to illustrate that in some cases, seral targets cannot be maintained throughout the entire 250-year planning horizon, especially in LU-BEC areas that mostly comprise of the NHLB. For example, in the BWBS mw2, only 1% of the LU-BEC combinations meet the old seral target 100% of the time throughout the entire planning horizon. This occurs for the deciduous component in the landscape unit Crow-BWBSmw2 with an intermediate BEO, where the THLB comprise of 59% of the 21,969 hectares of total productive forested area. Conversely, 30% of the LU-BEC combinations in the BWBSmw2 (or 36 out of 122) were met less than or equal to 50% of the duration of the planning horizon. In these 36 LU-BEC areas, approximately 88% of the total forested land base is in the NHLB; therefore, natural disturbances in the NHLB are significant in not achieving old seral targets.

Table 8: Maintenance of seral targets—Percent of landscape unit-biogeoclimatic zone combinations that met the old and mature plus old seral targets over the planning horizon

BEC variant	Seral Stage	% of Old and Mature+Old Forest Target Met Over a 250 Year Planning Horizon							Total Number of LU-BEC
		≤ 50%	51 - 60%	61 - 70%	71 - 80%	81 - 90%	91 - 99%	100%	
BWBSdk 1	Old	36%	27%	27%	9%				11
BWBSdk 2	Old	58%	24%		18%				33
BWBSmw 2	Old	30%	21%	22%	16%	9%	2%	1%	122
BWBSwk 3	Old	57%	14%	10%	14%	5%			21
SWB mk	Old	74%	21%	4%					47
SWB mks	Old	100%							17
BWBSdk 1	Mature+Old	27%		18%	36%	9%		9%	11
BWBSdk 2	Mature+Old	39%	3%	18%	12%	9%	6%	12%	33
BWBSmw 2	Mature+Old	12%	12%	12%	24%	16%	5%	18%	122
BWBSwk 3	Mature+Old	19%	14%	10%	33%	5%	5%	14%	21

4.5 Visual Quality Objectives in the Base Case

Visual quality objectives (VQO) are managed according to the *Procedures for Factoring Visual Resources into Timber Supply Analyses* (MoF, 1998). Based on the VQO, each VQO polygon has a maximum percent denudation, which determines the percent of the VQO polygon that can have trees that are shorter than the visually effective green-up (VEG*) height. The VEG height is determined based on the average slope of the VQO polygon. For further details on the modelling of VQOs, please refer to the data package (Appendix 4, Section 18.2). The licensees in the Fort Nelson TSA are managing for both established and recommended VQOs.

Of the 326 established VQO polygons, 302 (93%) currently meet the VQO target (Table 9). For the recommended VQOs, 71 out of the 82 VQOs (85%) currently meet the VQO target. The achievement of VQO targets over time is largely influenced by the natural disturbance in the NHLB, similar to old growth targets, as discussed in the above section. The maintenance of VQO targets over time is shown in Table 10. For example, all five of the VQO polygons with preservation visual objectives meet their VQO targets less than 50% of the time over the 250-year forecast horizon. A closer examination of the analysis reveals that only one of the five VQO polygons has had some harvesting during the same forecast horizon, which were at times when the VQO target was not violated. In these five VQO polygons, 3 to 38% of the CFLB is in the THLB, suggesting the underachievement of VQO targets is mostly influenced by the natural disturbance in the NHLB.

Table 9: Percent of visual quality objective polygons that first met the VQO target by the time period class

VQO Status	Visual Quality Objective Category	Time Period VQO Target Was First Met							Total Number of VQO Polygons*
		0 years	1 - 5 years	6 - 10 years	11 - 20 years	21 - 35 years	36 - 50 years	50+ years	
Established	Preservation	100%							5
Established	Retention	85%	4%	2%	4%		2%	4%	52
Established	Partial Retention	91%	1%	2%	4%	3%			111
Established	Modification	96%		4%	1%				139
Established	Maximum Modification	100%							19
Recommended	Retention	100%							2
Recommended	Partial Retention	83%		2%	2%	4%	10%		52
Recommended	Modification	92%		4%		4%			26
Recommended	Maximum Modification	100%							2

*Note only VQO Polygons with THLB ≥1 ha were included in the analysis. There are 165 VQO polygons that contained < 1 ha in the THLB.

Table 10: Maintenance of VQO target—Percent of visual quality objective polygons that met the VQO target over the planning horizon

VQO Status	Visual Quality Objective	% of VQO Target Met Over a 250 Year Planning Horizon							Total Number of VQO Polygons*
		≤ 50%	51 - 60%	61 - 70%	71 - 80%	81 - 90%	91 - 99%	100%	
Establish	Preservation	100%							5
Establish	Retention	58%	15%	13%	10%	2%		2%	52
Establish	Partial Retention	9%	18%	27%	23%	9%	8%	5%	111
Establish	Modification	1%	4%	6%	27%	37%	17%	9%	139
Establish	Maximum Modification				5%	21%	53%	21%	19
Recommend	Retention	100%							2
Recommend	Partial Retention	37%	15%	19%	12%	10%	2%	6%	52
Recommend	Modification		15%	12%	31%	19%	8%	15%	26
Recommend	Maximum Modification							100%	2

*Note only VQO Polygons with THLB ≥1 ha were included in the analysis. There are 165 VQO polygons that contained < 1 ha in the THLB.

4.6 Green-up adjacency constraints in the base case

For THLB areas without VQOs, also known as the integrated resource management zone, cutblock adjacency constraints are applied using green-up objectives, rather than by VEG height as in the case of VQOs. Green-up objectives require a logged block to reach a certain height target (green-up of 3 metres) before a neighbouring area can be harvested. Refer to Appendix 4, Section

18.1 for further details. These green-up or adjacency rules are applied to each landscape unit and management zone (e.g. general resource development, enhanced, and special management zones). There are 114 landscape unit-resource management zone combinations in the TSA. The timber supply model uses the green-up rules as constraints to timber supply throughout the 250-year planning horizon.

5 Sensitivity Analyses

Sensitivity analyses have several functions in timber supply analysis. First, they give an understanding of the contribution of specific assumptions to the timber supply dynamics of the base case. They can sometimes highlight the large impacts of seemingly insignificant uncertainties about some variables on timber supply projections. Conversely they can illustrate that fairly large inaccuracies in other variables could have negligible timber supply effects. Sensitivity analyses also verify that the forest estate model is applying the harvesting constraints correctly by comparing the expected harvest trend with that from the modeled sensitivity analysis. Finally, they provide the chief forester with an indication of the risk associated with the AAC determination in the context of major uncertainties.

In this document, sensitivity analyses are provided to investigate issues associated with harvesting rules, the size of the land base, the yield tables, and forest cover objectives. In all sensitivity analyses the unsalvaged losses associated with natural forces such as insects and fire (106,355 m^3/year) have been subtracted from the harvest forecasts provided in this report.

5.1 Harvest Level Calculation for Sensitivity Analyses

The base case and sensitivity analyses were calculated using an even flow criterion. Use of a consistent harvest flow criterion allows effective comparisons between the base case and sensitivity analyses. However, when the sensitivity analysis puts a downward pressure on the harvest level, an even-flow harvest level creates the illusion of downward pressure on the short term when in fact there may not be any. In other words, the base case harvest level can be maintained in the short and medium terms of some sensitivity analyses, even though the long-term harvest level must be reduced.

For sensitivity analyses, which result in a harvest level reduction, they were tested whether the base case harvest level of 3,163,000 m^3/year could be maintained in the short and medium terms before declining to the long-term harvest level. The long-term harvest level is defined as beginning at 130 years from present (Section 5.1). The transition from medium- to long-term harvest levels does not decline more than ten percent per decade. The method for determining harvest levels in sensitivity analyses used the following decision path as shown in Figure 22.

Note that for all sensitivity analyses that maintain a higher harvest level in the short- and medium-term before declining to a lower long-term harvest level, the even flow projections would be that of the long-term harvest level; therefore, comparisons to the base case harvest level may also be compared when based on the even flow criterion.

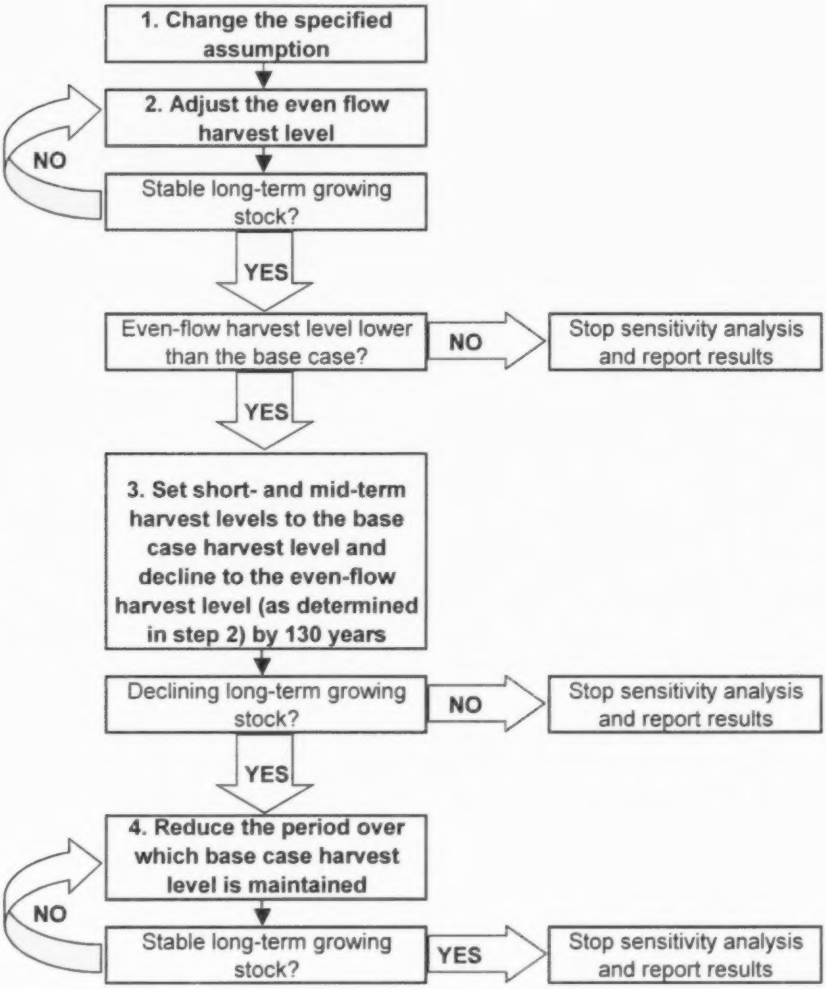
1. Change the specified assumption
2. Adjust the even flow harvest level
NO
Stable long-term growing stock?
YES
Even-flow harvest level lower than the base case?
NO
Stop sensitivity analysis and report results
YES
3. Set short- and mid-term harvest levels to the base case harvest level and decline to the even-flow harvest level (as determined in step 2) by 130 years
Declining long-term growing stock?
NO
Stop sensitivity analysis and report results
YES
4. Reduce the period over which base case harvest level is maintained
NO
Stable long-term growing stock?
YES
Stop sensitivity analysis and report results

Figure 22: Method for determining harvest levels in sensitivity analyses

5.1.1 Rationale for setting the long term at 130 years

The long term occurs from the point in the planning horizon beyond which the age structure of the THLB is in relative equilibrium as well as when the majority of harvest comes from second rotation stands. The age structure and harvest progression of the base case (Figure 23 and Figure 24) both indicate that 130 years is a reasonable definition of the long term. Up to that point, the age structure of the TSA is in transition, and the majority of harvest comes from naturally regenerated (first rotation) stands. By definition, the long-term harvest level should be applied from the beginning of the long term. For this reason, sensitivity analyses were conducted so that the long-term harvest commenced at 130 years from present.

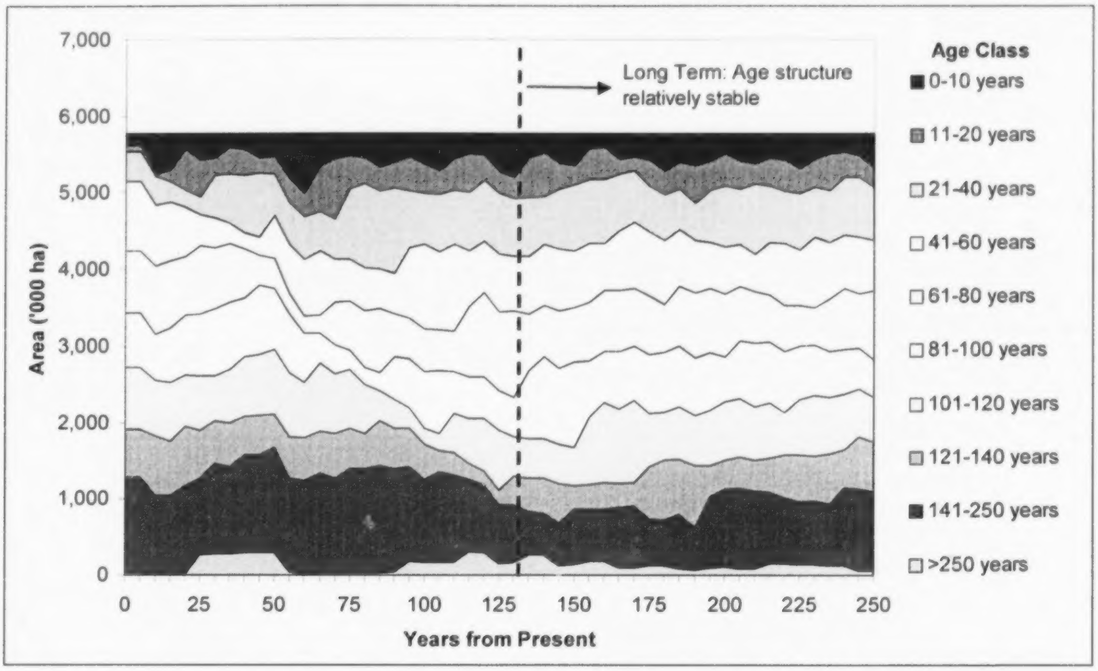

Figure 23: Age structure for the first 250 years of the planning horizon, demonstrating relative equilibrium beyond 130 years

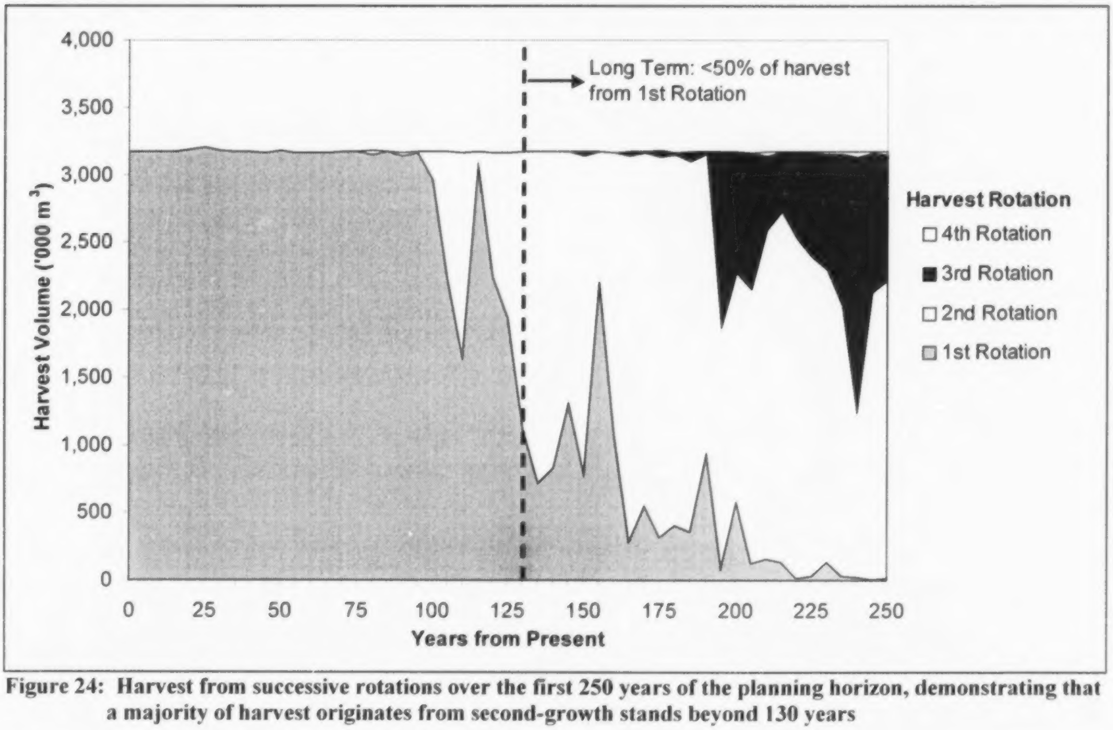

Figure 24: Harvest from successive rotations over the first 250 years of the planning horizon, demonstrating that a majority of harvest originates from second-growth stands beyond 130 years

5.2 Alternative Harvest Flows Over Time

Alternative harvest flows are harvest forecasts that meet the same set of current forest constraints on the land base but differ by its species harvest target and/or harvest pattern. Choosing harvest patterns such as 'falldown' versus even-flow and targets for species are social choices and are examined in this section.

The first alternative harvest flow maintains the same harvest level and relative oldest first rule, except analysis units with pure conifer or conifer leading stands would have a harvest priority of 1.5 (the default is 1). The harvest priority is modeled as a weighting. With a harvest priority of 1.5, conifer stands that are above the MHA, will have their stand age multiplied by 1.5 thereby increasing the relative priority, and hence a greater chance of being harvested compared to deciduous stands with a priority rating of 1. Note that the multiplication of stand ages affects only the place of the stand in the harvest queue. The actual age of the stand is not changed.

Results show that after increasing the harvest priority of the coniferous stands, the average harvest is 1,769,500 m^3/year from coniferous species and 1,393,500 m^3/year from deciduous species (Figure 25) for the 250 modeling horizon. In the short-term (e.g. first 35 years), the average conifer and deciduous harvests are 2,113,000 m^3/year and 1,049,000 m^3/year, respectively. In contrast, the base case harvest levels for the same period are 1,105,000 m^3/year from conifers and 2,058,000 m^3/year from deciduous. There is enough growing stock in the land base for flexibility in targeting harvest from these two species group.

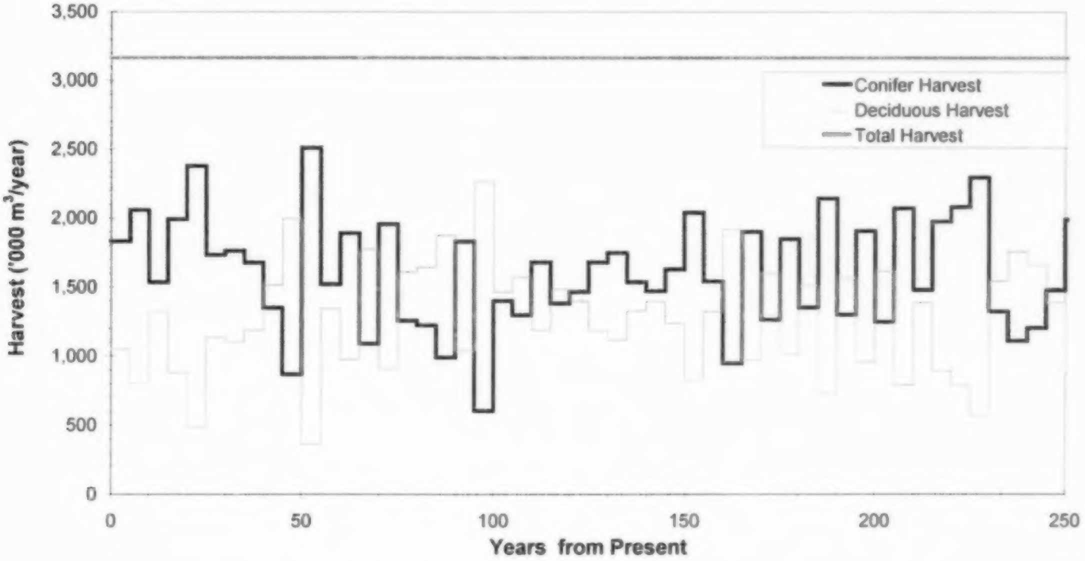

Figure 25: Harvest forecast for alternative flow 1

The base case for this timber supply analysis was modelled as an even flow, meaning that a similar harvest level is maintained throughout the entire planning horizon. However, the legacy of high-volume, old growth forests remaining in the THLB can allow harvest levels in the short-term to be higher than the long-term harvest level (i.e. "taking a falldown"). The alternative harvest forecasts test opportunities for increasing the initial harvest level without compromising the sustainability of the long-term harvest level. In alternative harvest flows 2 and 3, the long-term timber supply never declines below 1% of the base case. Two alternative harvest flows are shown in Figure 26.

The second alternative harvest forecast shows that 3,904,000 m^3/year can be harvested for the first 55 years (or 23% increase from the base case), followed by a 10% decline every 10 years before maintaining a long-term harvest of 3,162,000 m^3/year after 75 years. The sum of the additional volume harvested over the first 75 years is 49.9 million m^3 compared to the base case harvest. With a higher harvest flow in the short and medium-terms, the growing stock is depleted sooner than in the base case (Figure 27). Furthermore, the growing stock of the alternative harvest flow takes much longer to recover to the same stable long-term growing stock as that of the base case (e.g. in 400 years versus 160 years in the base case).

The third alternative harvest forecast shows that a 24.6% increase (3,941,000 m^3/year) from the base case is possible over the first 60 years, followed by a 10% decline every decade before maintaining a long-term harvest of 3,161,000 m^3/year after 85 years (Figure 26). The total extra volume harvested during this period is 59.9 million m^3. This alternative harvest is initially slightly higher and can be sustained longer than the alternative 1 harvest; however, the long-term sustainable growing stock is considerably less than that of alternative 1 (Figure 27). Moreover, the additional harvesting depletes the growing stock more rapidly due to the increased harvest over the first 60 years. However, growing stock stabilizes once the base case harvest level is resumed at year 85. The long-term growing stock associated with the second alternative harvest forecast is however, 41.2 million m^3 lower than the base case (Figure 28).

The alternative 2 and 3 harvest forecasts illustrate that the even flow approach creates a conservative base case. Existing stands could be harvested more rapidly in the short- and medium-terms than suggested in the base case, while still achieving the same long-term harvest level and avoiding future timber supply disruptions. The large surplus of growing stock that is not being utilized in the base case helps alleviate some of the downward pressures being tested in the sensitivity analyses. Nevertheless, the conservative even flow approach was chosen for this timber supply analysis due to uncertainties in the forest cover inventory and the effect of combining the conifer and deciduous land bases. The even flow also avoids the necessity for mid-term reductions in the timber supply and therefore provides a level of economic stability for the TSA.

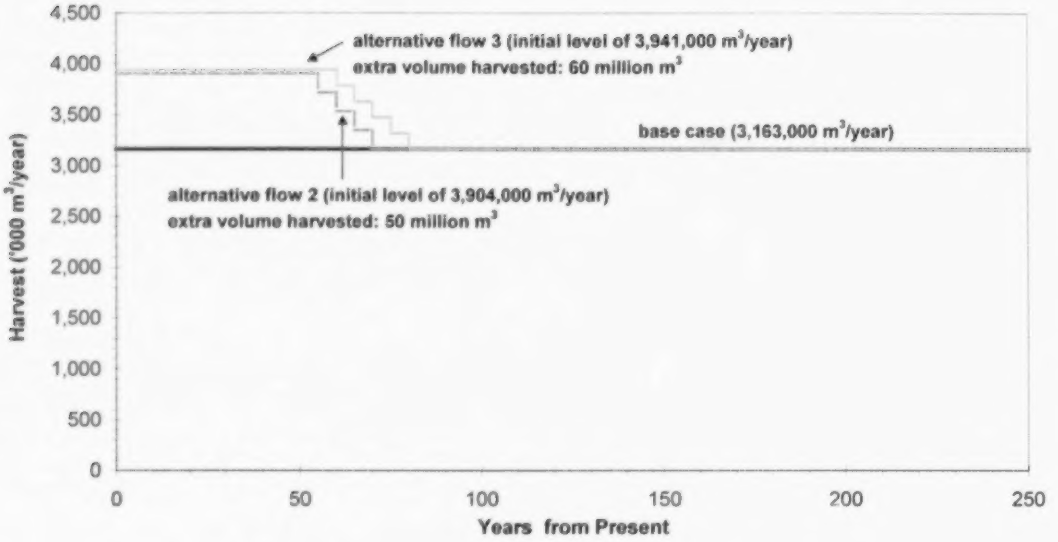

Figure 26: Alternative harvest forecasts using base case assumptions

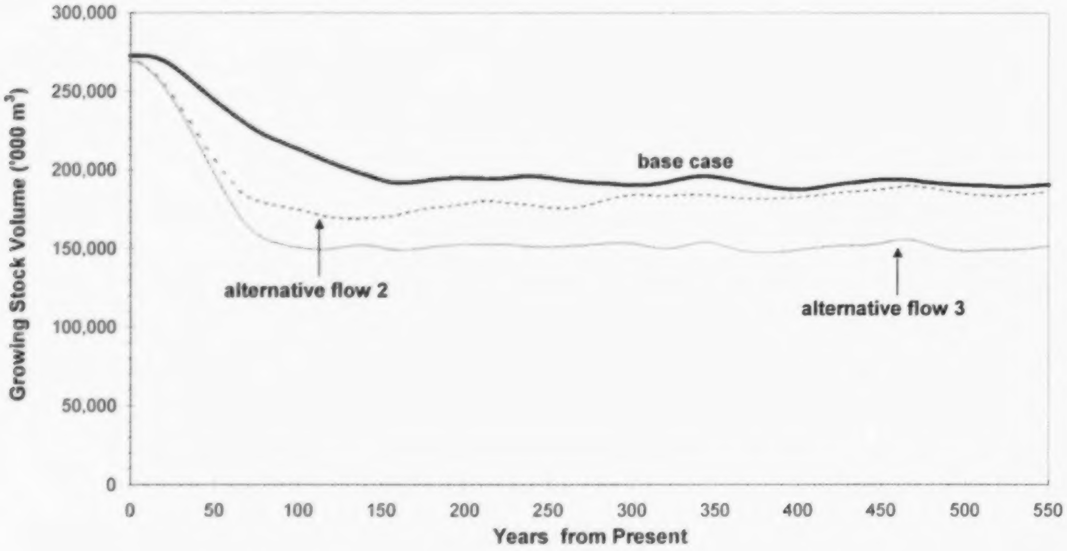

Figure 27: Total growing stock of the alternative harvest forecasts

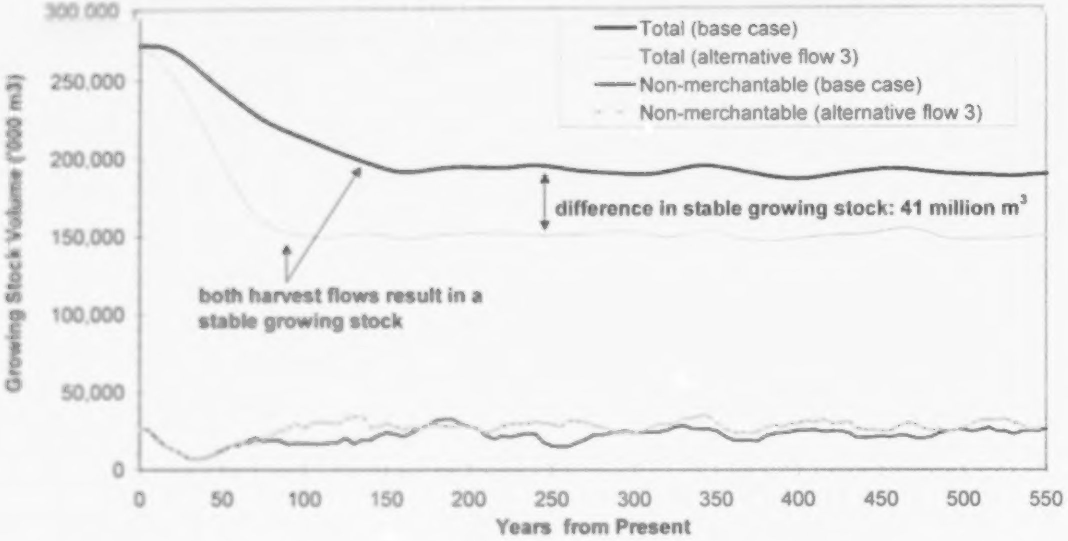

Figure 28: Growing stock of the falldown (alternative) and the even-flow (base case) harvest forecasts

5.3 Harvest scheduling rules

In any given period of the planning horizon, areas within the Fort Nelson TSA may be unconstrained and available for harvesting. Harvest scheduling rules defines the criteria by which a timber supply simulation model selects polygons for harvest. The order that polygons are harvested affects the development of growing stock and is potentially important to timber supply, especially in the transition period to the long-term planning horizon. The purpose of this sensitivity analysis is to determine the role of harvest scheduling rules on the base case.

The base case was modelled with a relative oldest harvest rule, which assumes that the oldest stands relative to their minimum harvest age (MHA*) would be harvested first. Given the physical and economic constraints in the Fort Nelson TSA, harvesting the oldest stands first may not always reflect operational practice. This sensitivity analysis tested the effects of scheduling harvests randomly, meaning that all stands older than their minimum harvest age are equally eligible for harvest, subject to other constraints.

No change in harvest levels was necessary at any point in the planning horizon for the random harvest schedule sensitivity analysis. However, growing stock under the random harvest rule is drawn down faster than the base case during the first 110 years of the planning horizon (Figure 29). The growing stock also reaches the long-term sustainable level earlier than in the base case (i.e. at 110 years versus 155 years in the base case). The long-term equilibrium growing stock is slightly lower in the random scheduling rule than in the base case. These results indicate that the relative oldest first rule exerts upward pressure on the timber supply, especially in the short- and medium-terms. However, the harvest levels in the base case are alleviated against this pressure due to the large surplus of growing stock not harvested in the short- and medium-terms due to even flow harvesting (see Section 5.2). Therefore, assumptions around harvest scheduling do not likely pose a significant risk to the base case harvest level.

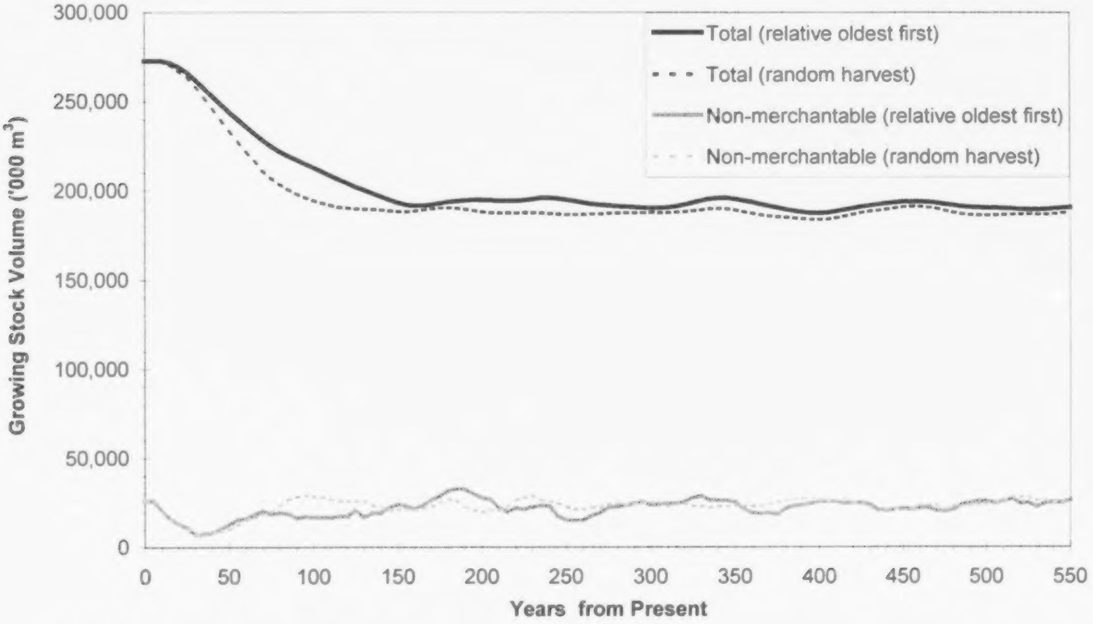

Figure 29: Growing stock under "relative oldest first" (base case) and "random" harvest scheduling

5.4 Uncertainty in the size of the timber harvesting land base

Several factors that are used to determine the size of the timber harvesting land base (THLB) have uncertainty around their definition (e.g. low productivity stands, inoperable areas, seismic areas, riparian areas, roads and landings, inventory accuracies, etc.). Future market conditions and changes in harvesting or milling technology may also cause a reduction or expansion of the timber harvesting land base.

This sensitivity analysis tests the impact of uncertainties on the overall size of the THLB. The sensitivity analysis was modelled with a 10% decrease in the THLB, resulting in a revised THLB area of 1,289,041 ha. For analysis purposes, the area removed from the THLB still remained as CFLB. A 10% decrease in the THLB required a 9.4% reduction to the harvest flow in the long term (Table 11 and Figure 30). However, the base case harvest levels for the first 120 years can be maintained due to the surplus growing stock available in this period. Therefore, uncertainties around the timber harvesting land base within a range of 10% pose little risk to the short-term harvest level.

Table 11: Harvest summary—10% decrease in the timber harvesting land base

			Long-term (≥ 130 years)		
Sensitivity Analysis	**Base Case Harvest (m^3/year)**	**Short and Mid-term (m^3/year)**	**Harvest from Sensitivity Analysis (m^3/year)**	**Change from Base Case (m^3/year)**	**% Change**
Decrease the timber harvesting land base by 10%	3,163,000	No change from base case for the first 120 years	2.865,000	-298,000	-9.4%

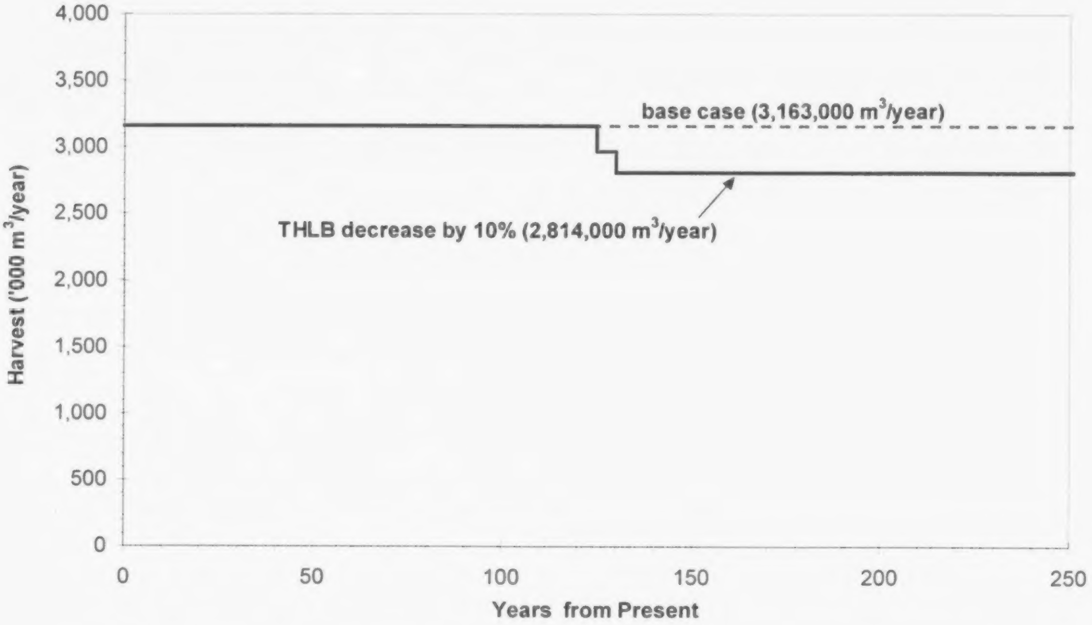

Figure 30: Harvest forecast with a timber harvesting land base that is 10% smaller in area

5.5 Uncertainty in stand volume estimates

Uncertainty in estimating volumes of natural stands can be caused by the inventory classification of stands, statistical generalization in the yield prediction model, decay estimates, waste and breakage estimates, and actual utilization levels practiced during harvesting. Estimates of timber volume in regenerated managed stands are also uncertain for similar reasons as natural stand volumes, compounded by a relative lack of long-term data about the growth and yield of managed stands.

There are four basic sensitivity analyses that can be undertaken to address uncertainties in existing and future stand yields:

1. **Increase existing stand yields by 10%**--This sensitivity analysis may put upward pressure on the short and medium terms (first 130 years of the planning horizon). However, there is already surplus growing stock in this period that is not being harvested because the base case harvest level is constrained to an even flow (see Section 5.1). This sensitivity analysis is therefore irrelevant and was not performed.
2. **Decrease existing stand yields by 10%**--This sensitivity analysis may put downward pressure on the short and medium terms. By definition, there is no pressure on the long-term timber supply in this sensitivity analysis, so harvest levels are only adjusted over the first 130 years.
3. **Increase future stand yields by 10 %**--Future stand yields do not form a majority of the base case harvest until 130 years into the planning horizon. Increasing future yields may put upward pressure on the long term-harvest level, but also make future stands available for harvest sooner, which reduces the amount of time before the long-term is achieved. This can produce upward pressures on the short-term (the "allowable cut effect"). Harvest levels are constrained to an even flow, and short-term harvest levels higher than the long-term harvest levels are not tested.
4. **Decrease future stand yields by 10 %**--similar to the effect of increasing stand yields, reductions in the productivity of future stands can put indirect downward pressures on the short- and medium-term timber supply. However, the surplus existing growing stock will alleviate these downward pressures and reduce the risk associated with uncertainties in future yields. To account for this alleviated effect on the harvest level, harvest levels in the short- and medium-terms were adjusted separately from the long-term harvest level.

Reducing existing stand yields by 10% typically puts substantial downward pressure on short and medium terms. Nevertheless, for the Fort Nelson TSA no change in harvest levels is required in this sensitivity analysis, due to the large surplus growing stock in existing stands (Table 12 and Figure 31). This result indicates that the even-flow harvest criterion in the base case suppresses any reductions in harvest associated with uncertainties in existing yields of up to 10%.

Increasing future stand yields by 10% allows a 11% increase in harvest levels throughout the planning horizon. This sensitivity analysis does not put any direct pressure on the short and medium terms. However, the combination of an allowable cut effect and the surplus growing stock are sufficient to maintain even flow despite the large increase in the long-term harvest level.

Reducing future stand yields by 10% allows the base case harvest to be maintained for the first 115 years before declining to the long-term harvest of 2,828,000 m^3/year at 130 years. The long-term harvest is 10.6% lower than the base case harvest.

Table 12: Harvest summary—stand volume estimates increased or decreased by 10%

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short and Mid-term Harvest (m^3/year)	Long-term (≥ 130 years)		
			Harvest from Sensitivity Analysis (m^3/year)	Change from Base Case (m^3/year)	% Change
Decreasing existing stand yields by 10%	3,163,000	No change from the base case	3,163,000	0.0	0.0%
Increase future stand yields by 10%	3,163,000	3,510,000	3,510,000	347,000	11.0%
Decrease future stand yields by 10%	3,163,000	Same as base case for the first 115 years	2,828,000	-335,000	-10.6%

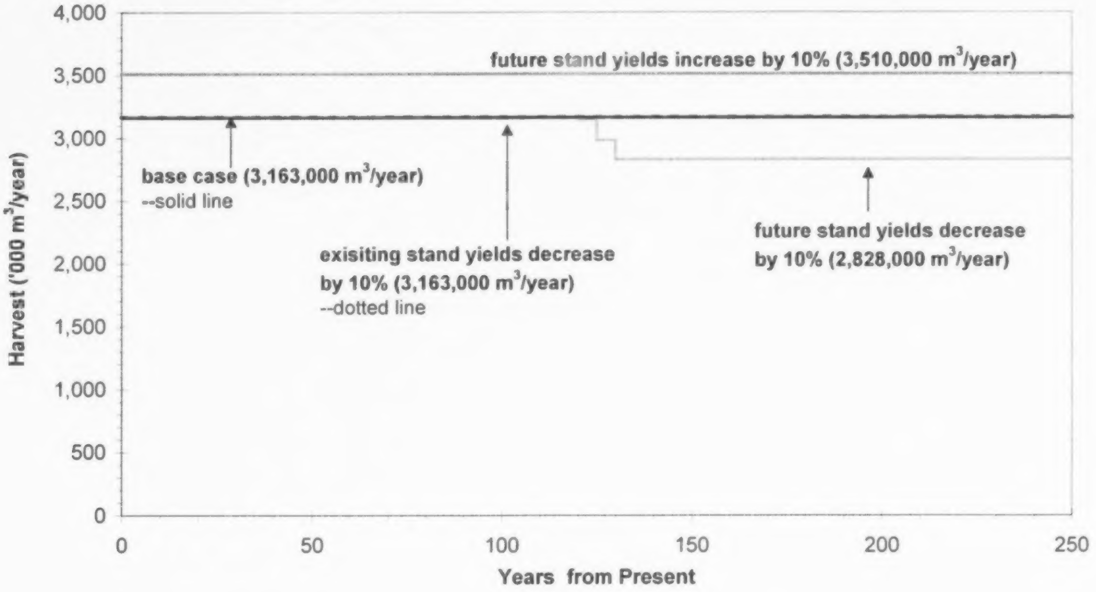

Figure 31: Harvest forecasts with adjustments to stand volumes

5.6 Uncertainty in the use of select seed

The *Forest and Range Practices Act* requires the use of best available genetic seed and vegetative material for regeneration treatments within management units in BC. Specific yield adjustments that recognize the use of select seed (orchard and superior provenance seed with a known Genetic Worth) are applied in the managed stand growth model (TIPSY). Class B seedlings, which have no effective genetic gain, have predominately been used in the Fort Nelson TSA. However, Class B+ seeds exhibiting a genetic worth of 3% have been used since 2000 for all planted pine types. All existing managed and future managed pine stands (potentially 290,692 hectares if all natural pine stands are harvested) are modelled with a 3% genetic gain after harvest in the base case.

In the base case, all existing managed and future managed pine stands (potentially 290,692 hectares if all natural pine stands are harvested) were modelled using genetic gain. Using new information provided by the Ministry of Forests and Range indicates that the superior pine provenance is only suitable for use in areas of elevation between 210 and 710 metres. Currently, there are 214,966 hectares of pine stands with elevation above 710 metres in the THLB (Table 13). Considering that this area amounts to approximately 15% of the total THLB, a 3% reduction to the yield curve would likely approximate a 0.45% (15% X 0.03) decrease to the base case harvest level. Please note that the error of using superior pine provenance in all elevations within the TSA for the base case likely has a small effect and no additional changes to pine yield curves were made to the base case or sensitivity analyses.

Table 13: Pure pine stands (analysis unit 6) with modelled 3% genetic gain by elevation class

Elevation	THLB (ha)	% of Pine THLB	% of total THLB
Above 710 metres	214,966	74	15
222 to 710 metres	75,717	26	5
Total	**290,683**	**100**	**20**

Class A spruce seedlings are expected to be available in the future for seed planning unit, SX PR MID and SX PR LOW. Two sensitivity analyses were conducted. The first sensitivity analysis assumes that the current request for Class A spruce seedlings apply in the future (e.g. 4.7% of the spruce seedlings planted in the TSA are from Class A seedlings). With an assumed genetic gain of 20% in Class A seeds, this translates to approximately a 1% overall modelled genetic gain (e.g. 1% X 0.0474).

The second sensitivity analysis assumes that enough Class A spruce seedlings are available for planting in all future managed spruce stands; therefore, a 20% average genetic gain was modelled to all future spruce growth and yield curves (refer to the data package, Appendix 4, Section 16.3 for more details). The use of 1% and 20% genetic gain spruce seeds resulted in a 1% and 6% increase in the harvest level, respectively (Table 14 and Figure 32).

Table 14: Harvest summary—use of spruce seedlings with genetic gain

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short-, Mid- and Long-term		
		Harvest from Sensitivity Analysis (m^3/year)	Change from Base Case (m^3/year)	% Change
Use existing and future managed spruce seedlings with 1% overall genetic gain	3,163,000	3,193,000	30,000	0.9%
Use existing and future managed spruce seedlings with 20% overall genetic gain	3,163,000	3,350,000	187,000	5.9%

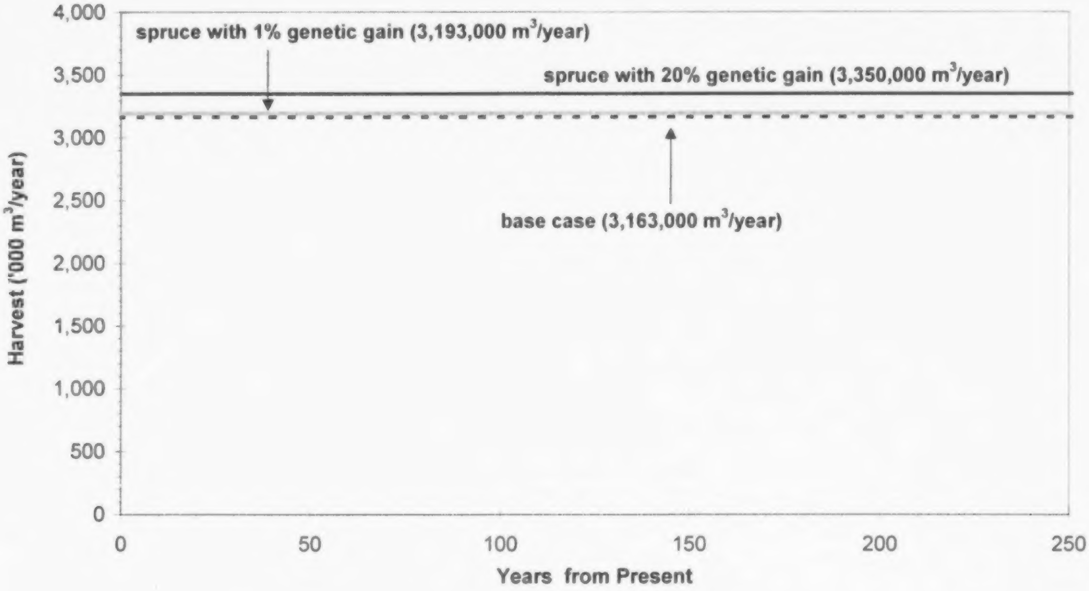

Figure 32: Harvest forecasts with the use of select spruce seeds

5.7 Uncertainty in minimum harvest ages

The minimum harvest age (MHA) is an estimate of the time needed for a stand to reach a merchantable condition. The stands become eligible for harvest within the timber supply model when they reach their minimum harvest age.

For the base case, MHA were estimated as the age at which stands reach a minimum volume of 140 m^3/ha (refer to the data package, Section 19.1 in Appendix 4 for more details). This method was chosen to ensure that only stands with sufficient stem size and merchantable volume would be considered for harvest. It should be noted that the MHA represents a minimum threshold and that harvesting can and often does occur well beyond these ages in the timber supply model.

The base case definition of minimum harvest ages is not dependent on the culmination age of future stands (i.e. the age at which the stand achieves its maximum average rate of volume production or maximum mean annual increment). There is a possibility that harvest levels are lower in the base case than they would be if the harvest scheduling was designed to harvest stands at or near culmination age. However, if MHA for a significant number of stands is higher than culmination age, these stands will be constrained to a rotation that is longer than the culmination age. This would put downward pressures on timber supply because the volume growth realized from stands harvested post-culmination is lower than their maximum.

Two sensitivity analyses were completed: 1) The MHA was defined as the age at which the stand reaches 95% of the its maximum mean annual increment (MAI), and 2) The MHA was set 20 years lower than in the base case.

When using the 95% of MAI approach, the MHAs are generally higher than those in the base case (MHAs using this method are shown in Appendix 4, Table 104 to Table 106 in the data package). However, changing the MHAs to 95% of maximum MAI had a negligible impact on timber supply throughout the planning horizon.

The use of younger ages (20 years younger than in the base case) as MHA tends to provide flexibility in the transition from the short-term to the long-term. In spite of this added flexibility, lower MHAs had no impact on timber supply. This sensitivity analysis indicates that there is sufficient surplus growing stock to transition to future stands without relying on harvesting stands close to their minimum harvest ages. Currently 71% of existing stands are at or exceed the base case MHA; therefore, it is not unexpected that increasing or decreasing the MHA has minimal affect on the timber supply (Table 15).

Table 15: Harvest summary—minimum harvest age and harvest rule

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short-, Mid- and Long-term		
		Harvest from Sensitivity Analysis (m^3/year)	Change from Base Case (m^3/year)	% Change
Set minimum harvest age at 95% of culmination age	3,163,000	3,163,000	0	0
Reduce minimum harvest age by 20 years	3,163,000	3,163,000	0	0

5.8 Uncertainty in approximations of green-up adjacency guidelines

The *Forest and Range Practices Act* requires that trees in a harvested area must reach a specified height (green-up height) before adjacent areas are harvested. To ensure that harvesting-related disturbance does not become overly concentrated in any area, it was assumed that a maximum of 39% of the THLB in each of the 85 landscape units in the Fort Nelson TSA could be covered by stands that have not achieved 3-metre in height. Forest cover requirements are used in the analysis as a proxy for adjacency guidelines and as such, some uncertainties surrounds this assumption. Nonetheless, the sensitivity analysis indicates that the base case harvest forecast is not affected if green-up height is increased to 8 metres from the 3 metre height assumed in the base case (Table 16).

Table 16: Harvest summary—green-up height increase by 5 metres

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short-, Mid- and Long-term		
		Harvest from Sensitivity Analysis (m^3/year)	Change from Base Case (m^3/year)	% Change
Increase green-up height by 5 metres	3,163,000	3,163,000	0	0

5.9 Uncertainty in stocking class

In the forest inventory, certain stand attributes are projected over time, such as stand volume, age, height, diameter and stocking class. The stocking class is an indication of the number of trees in a given area (or how dense or open a stand is). In February 2005, the Ministry of Forests[6] indicated that the stocking class for some of the areas in the VRI roll-over had been projected with an incorrect stocking class due to a software problem. A comparison between the correct stocking class and the stocking class that was used for this analysis showed that 28,183 hectares were projected with the wrong stocking class (or 2% of the THLB). Results from the comparison shows:

- The stocking class used in this analysis for the 28,183 hectares overestimates the number of trees per hectare,
- The area consists mainly of lodgepole pine -leading stands,
- The area mainly covers poor sites, and
- The area contributes about 1% to the total harvest, averaged over a 250 year planning horizon.

The information regarding the incorrect stocking class was discovered too late for changes to be made in the base case. A sensitivity analysis was used to investigate the potential impact of the incorrect stocking class by removing the 28,183 ha with the incorrect stocking class from the THLB.

The impact of removing the area from the THLB was confined to the long-term and only amounts to a 1% reduction in harvest flow (Table 17 and Figure 33). This sensitivity analysis indicates the maximum possible negative impact of the error. The true impact of the incorrect stocking class is likely less given that many stands exhibiting the error are or will be eligible for harvest. This result indicates that the stocking class error has no effect on the short-term harvest level.

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[6] Pers. Comm. Rob Drummond, Growth and Yield Prediction Specialist

Table 17: Harvest summary—exclude areas with inaccurate projected stocking class

Sensitivity Analysis	Base Case Harvest (m³/year)	Short and Mid-term (m³/year)	Long-term (≥ 130 years)		
			Harvest from Sensitivity Analysis (m³/year)	Change from Base Case (m³/year)	% Change
Areas with the wrong projected stocking class are excluded	3,163,000	No change from the base case for the first 125 years	3,129,000	-34,000	-1.1%

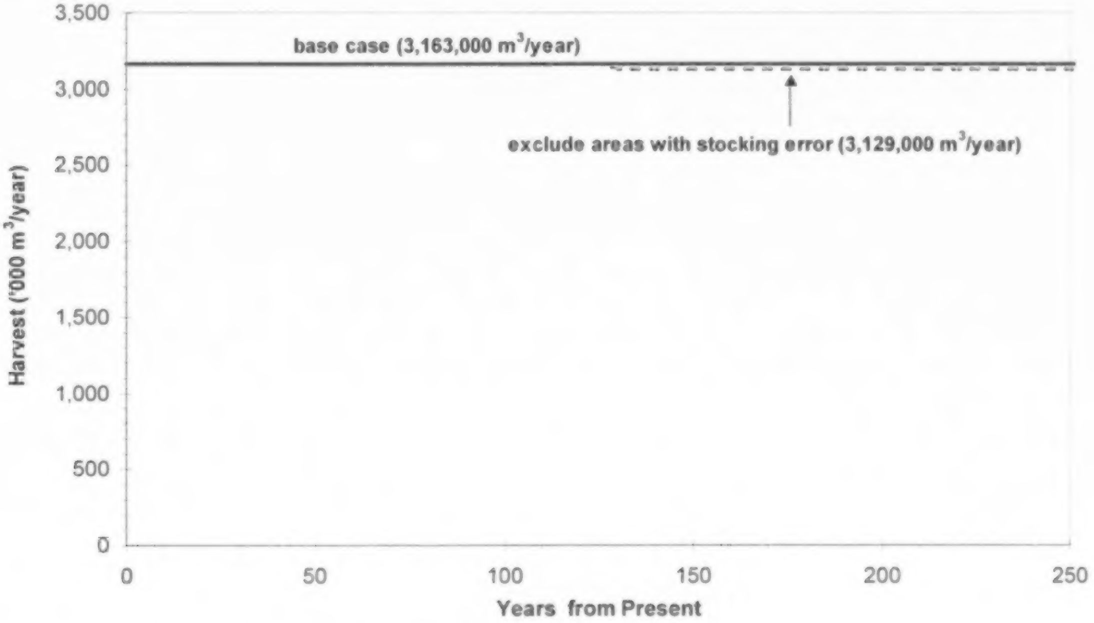

Figure 33: Harvest forecasts when areas with the wrong projected stocking class are excluded

5.10 Uncertainty about the utilization of birch-leading stands

There is some interest in the TSA in the harvest, processing, and marketing of birch. A preliminary assessment indicates that immature birch-leading stands (e.g. stands less than 51 years old) with a site index greater than or equal to 16.8 could be merchantable. Mature stands, which are greater than or equal to 51 years old, and have a minimum stand volume of 140 m³/ha and a minimum height of 16 metres are also considered merchantable. The inventory indicates that there is a total forested area of 248,500 ha of birch-leading stands within the TSA and of that there would be an additional 63,475 ha (4.4%) to the THLB for those that satisfy the merchantable criteria. If market conditions remain favourable for birch stands, the overall harvest forecast could increase by 4% (Table 18 and Figure 34).

Table 18: Harvest summary—use of birch-leading stands

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short-, Mid- and Long-term Harvest from Sensitivity Analysis (m^3/year)	Change from Base Case (m^3/year)	% Change
Harvest birch-leading stands that meet certain harvest criteria	3,163,000	3,288,000	125,000	4.0%

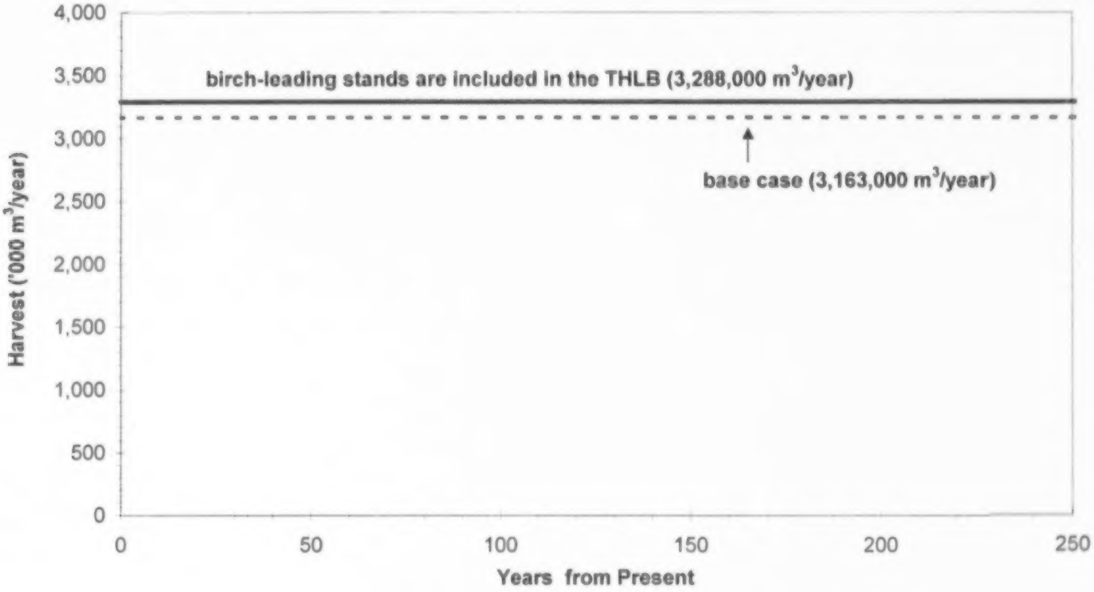

Figure 34: Harvest forecast with birch-leading stands in the timber harvesting land base

5.11 Uncertainty in small pine

A review of recent harvest data as well as cut blocks from the licensees' forest development plans showed that approximately 25-30% of the pine stands harvested in the Fort Nelson TSA were from "small pine" stands. Small pine stands are defined as those that are older than or equal to 81 years of age, whose stand height is between 16 and 20 metres and whose volume is greater than 140 m^3/ha. Considering that small pine stands are currently being harvested in the TSA, it was decided that the 186,940 hectares of small pine stands remain in the base case THLB. Although these logs can be processed in the Fort Nelson mills, there are some concerns over the feasibility (e.g. distance to road) of reaching these stands[7].

A sensitivity analysis was conducted whereby small pine stands were removed from the THLB resulting in a 13% reduction or a resulting THLB of 1,239,669 hectares. This reduction required a 9% decrease in the long-term harvest level to 2,875,000 m^3/year (Table 18 and Figure 34). The short and medium term harvest level was not affected by this reduction and remained at base case harvest levels.

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[7] Approximately 80,000 hectares of the small pine stands in the timber harvesting land base are located in the Cassiar Addition.

Table 19: Harvest summary—removal of small pine stands from the timber harvesting land base

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short and Mid-term (m^3/year)	Long-term (≥ 130 years)		
			Harvest from Sensitivity Analysis (m^3/year)	Change from Base Case (m^3/year)	% Change
Small pine are excluded from harvest	3,163,000	No change from the base case for the first 120 years	2,875,000	-288,000	-9%

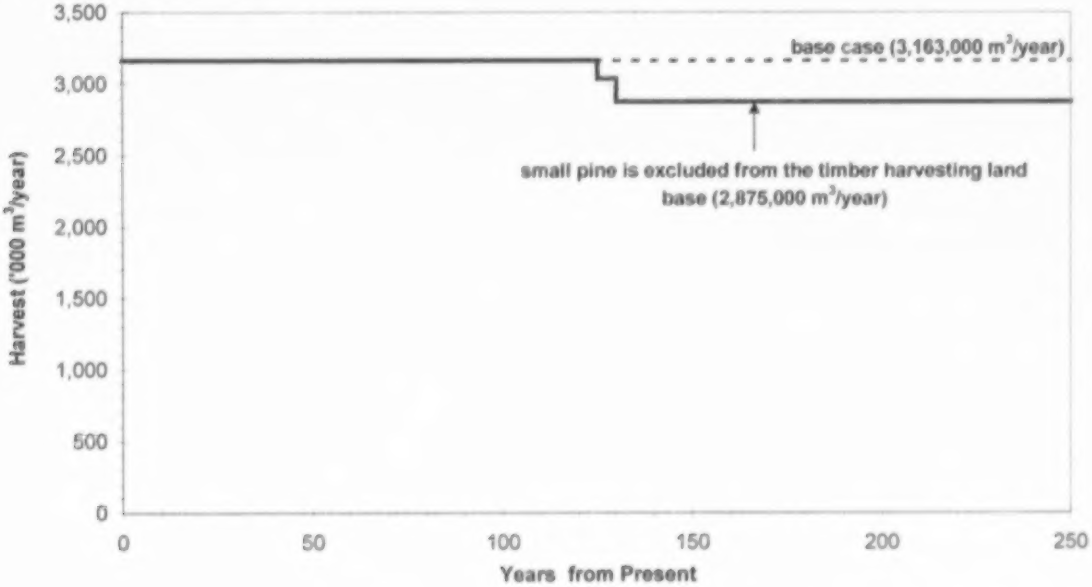

Figure 35: Harvest forecast with small pine stands removed from the timber harvesting land base

5.12 Uncertainty in site productivity estimates

The base case site productivity estimates are based on the existing inventory of natural stands: site indices for each stand are derived from stand age and height. This method generally works adequately for immature and mature stands. However, existing stand attributes are poor indicators of site productivity in very young and very old stands. SIBEC is a correlation between site index and site series within the biogeoclimatic ecosystem classification (BEC), giving an ecosystem-specific estimate of potential site productivity that is independent of current stand condition. Where ecosystem mapping is available, SIBEC is an alternative means of assigning site index to harvested and regenerated stands.

In the Fort Nelson TSA, predictive ecosystem mapping (PEM) and terrestrial ecosystem mapping (TEM) have been completed on 1.82 million hectares and 1.19 million hectares, respectively. Ecosystem mapping covers approximately 560,963 hectares in the THLB (or 39% of the THLB). This mapping uses site series as the basic ecosystem map units. Accuracy assessments for the PEM and TEM projects in the Fort Nelson TSA were incomplete at the time of the analysis, which precludes their use in the TSR3 Base Case.

This sensitivity analysis tests the impact of adjusting the existing set of yield curves based on SIBEC values for regenerated stands in those areas of the Fort Nelson TSA that contain PEM and TEM mapping. SIBEC adjustments are only available for spruce, pine, and subalpine fir, which totals 266,809 hectares for those species with PEM and TEM mapping. Site indices of deciduous-leading stands were not adjusted. Of the 266,809 hectares of THLB that were adjusted for SI, an additional 33,534 hectares were excluded from the THLB due to the low growing potential criteria for immature stands. Please refer to Appendix 11 for more details on the methodology behind the SIBEC analysis.

In modelling the growth and yield of areas with SIBEC adjustments, the 'closest neighbour' approach was taken. Polygons with SIBEC adjustments were assigned to the closest yield curve (i.e. it may be assigned to a yield curve with similar species composition but with a higher site productivity). In general, stands from poor or rich sites were adjusted to a medium productive site yield curve and stands from the medium site productive curves either remained in the same site class or were reassigned to the poor site yield curve. The site indices from the SIBEC adjustments are generally lower than those from the Vegetation Resources Inventory as shown in Figure 36.

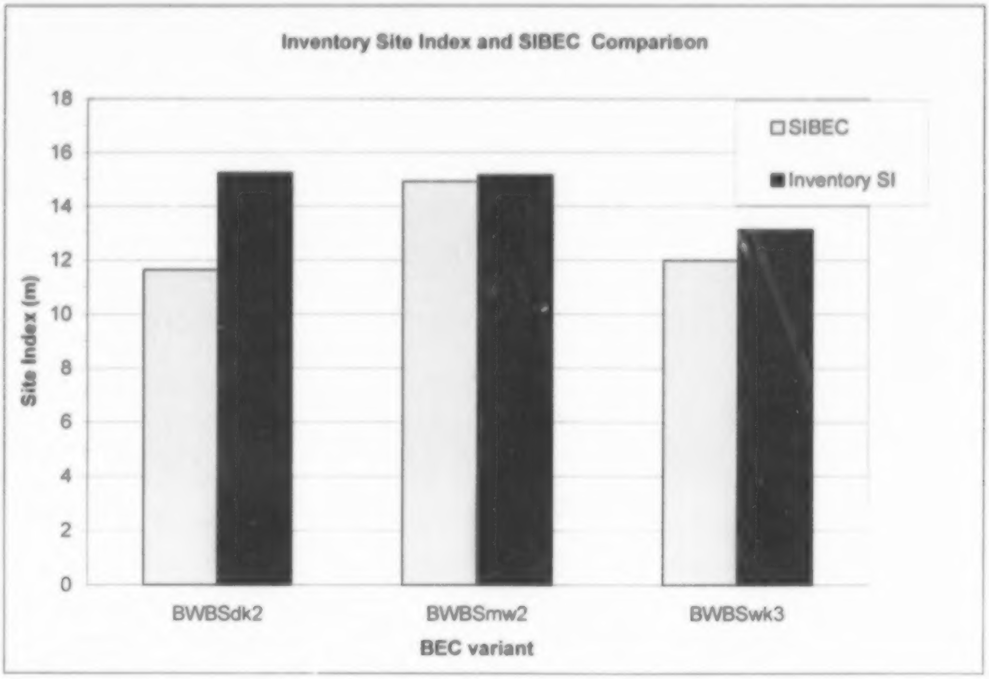

Figure 36: Comparison of inventory site index with site indices estimates from site series by BEC variant

SIBEC returns lower potential productivity than the inventory, and consequently required a 3% reduction in the long-term harvest level (Table 20 and Figure 37). There is no impact on the short- and mid-term harvest level.

Table 20: Harvest summary—SIBEC adjustments

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short and Mid-term (m^3/year)	Long-term (≥ 130 years) Harvest from Sensitivity Analysis (m^3/year)	Long-term (≥ 130 years) Change from Base Case (m^3/year)	Long-term (≥ 130 years) % Change
Use SIBEC in analysis	3,163,000	No change from the base case for the first 125 years	3,068,000	95,000	-3%

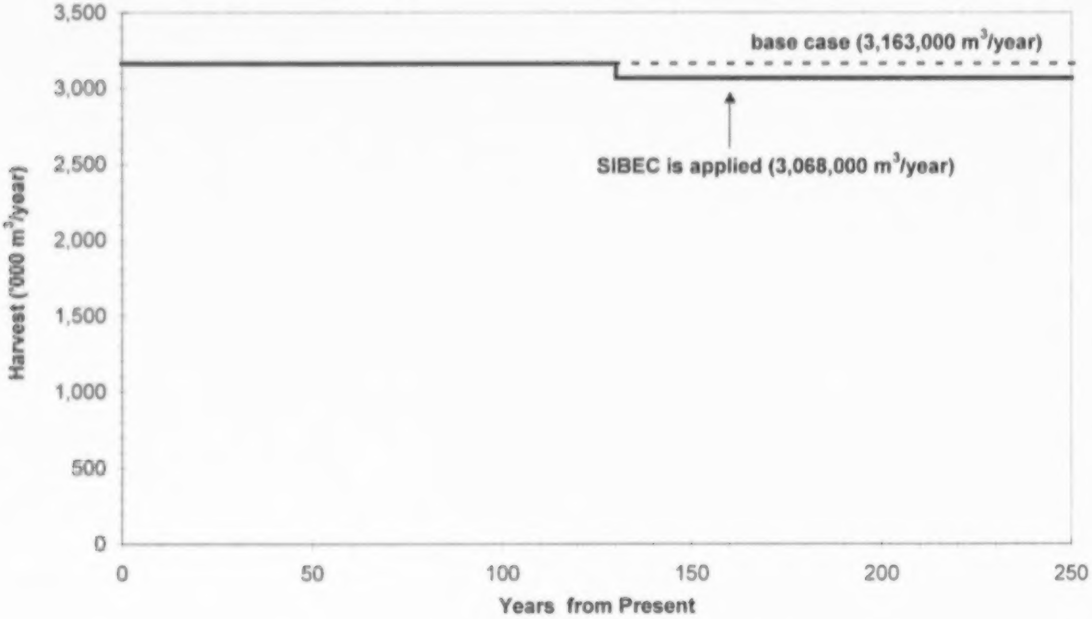

Figure 37: Harvest forecast with SIBEC adjustments applied to PEM and TEM areas

5.13 Uncertainty in using site productivity to identify low growing potential in immature stands

Defining the THLB for the base case analysis included a reduction for low growing potential for immature stands, which involved setting minimum site productivity thresholds. Stands below these criteria were excluded from the THLB. Minimum stand volume and height, in conjunction with an assessment of past performance, were used to estimate the site productivity thresholds for low growing potential. Because of the uncertainty in site productivity in the inventory as compared to on the ground, three sensitivity analyses were conducted to test the impact on the base case harvest level if the minimum site productivity thresholds were higher or lower.

The first sensitivity analysis assesses the impact of using higher site productivity thresholds to determine the low growing potential. The modified thresholds, as shown in Table 21, were chosen based on the 1998-2003 harvest data and the 'tail end' of a relatively normal distribution of their site indices. Adjustments reflecting the site productivity thresholds were made to the netdown table, Table 5(i.e. subsequent land base deductions were made such as for riparian areas, environmentally sensitive areas and stand-level biodiversity). The resulting THLB is 1,313,642 hectares or 8% less than the base case THLB. Consequently, the non-harvestable forested land base increases by 2% when the site index thresholds are adjusted for immature stands, which would increase their contribution to achieving seral stage and forest cover objectives.

Raising the site productivity threshold for immature stands results in an 8% decrease in the long-term harvest level relative to the base case (Table 22 and Figure 38). The change in the site productivity thresholds likely puts some downward pressure on the medium term and indirectly on the short term because the stands under question are currently immature. Nevertheless, the base case harvest level can be maintained until the long-term due to the surplus growing stock, which contains stands older than the MHA.

Two other sensitivity analyses were requested by the Fort Nelson forest district staff to investigate the impact on the harvest level when the minimum site index thresholds are reduced to 10 metres for immature pine and 13 metres for immature aspen. The district staff felt that these lower site indices stands might be operable. By allowing more of these low productive sites to be harvested, the timber harvesting land base increased by 22% or 309,957 hectares for the immature pine sensitivity and increased by 8% or 115,654 hectares for the immature aspen sensitivity analysis. The reduced minimum site indices allowed the base case harvest to increase by 15.5% and 5% for the immature pine sensitivity and immature aspen sensitivity, respectively (Table 22 and Figure 38).

Table 21: Minimum site index criteria used for immature stands

	Base Case SI	**SI used in sensitivity analysis with higher minimum SI[1]**	**SI used in sensitivity analysis for lower minimum SI for pine**	**SI used in sensitivity analysis for lower minimum SI for aspen**
Aspen	15.9	17.5	15.9	13.0
Cottonwood	14.0	17.0	14.0	14.0
Pine	16.4	18.0	10.0	16.4
Spruce	10.8	12.5	10.8	10.8
Balsam	12.0	12.4	12.0	12.0

[1] These site indices were chosen based on an analysis of site index distribution in past harvest areas and in the current timber harvesting land base, as well as, consultation with the DFAM Group.

Table 22: Harvest summary—changes in the site productivity thresholds for immature stands

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short and Mid-term Harvest (m^3/year)	Long-term (≥ 130 years)		
			Harvest from Sensitivity Analysis (m^3/year)	Change from Base Case (m^3/year)	% Change
Apply a higher minimum SI criteria to all immature stands	3,163,000	Same as base case for the first 120 years	2,909,000	-254,000	-8.0%
Apply a lower minimum SI criteria to immature pine	3,163,000	3,652,000	3,652,000	489,000	15.5%
Apply a lower minimum SI criteria to immature aspen	3,163,000	3,321,000	3,321,000	158,000	5.0%

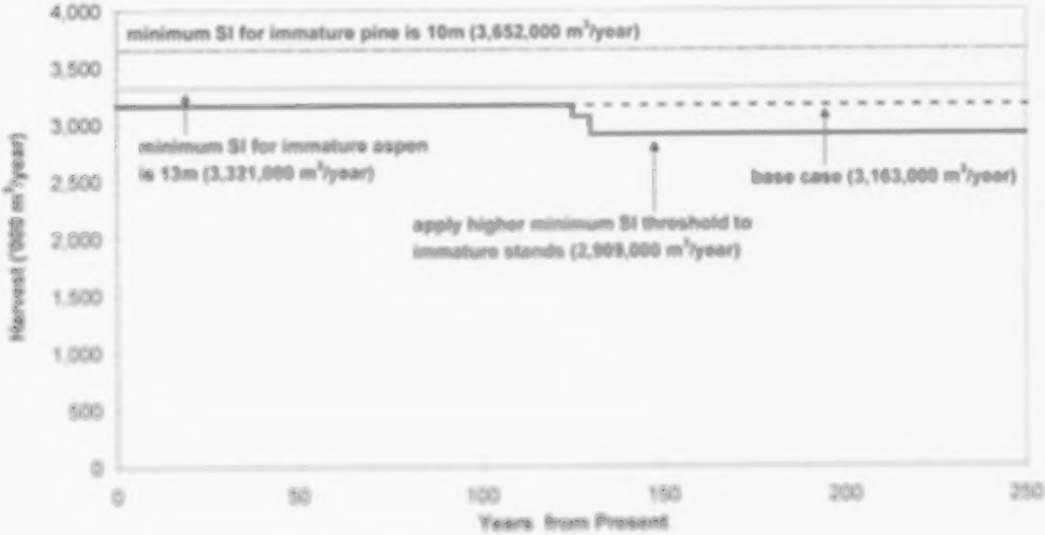

Figure 38: Harvest forecast with different site productivity rules

6.14 Uncertainty in harvesting in the Fort Nelson West, small pine and immature aspen

In defining the timber harvesting land base during the data package process of the timber supply review, the operability of the land base was determined based on stand attributes, harvest method and availability of the land base (Section 13.4.11, Appendix 4).

Feasibility of harvesting in the "Fort Nelson West" area, defined by the DFAM group (see Figure 39) is uncertain due to a combination of marketplace issues (prices and demand) high harvest and transportation costs, and lack of a developed road network other than the Alaska Highway. The

DFAM group is not planning any harvesting in this area over the next five or more years. The total area of the Fort Nelson West is approximately 4.6 million hectares and with a THLB area of 370,715 hectares. This is a diverse area, which includes parts of the Muskwa-Kechika Special Management area[8] and several parks and protected areas.

Small pine stands are defined as Inventory Type Group 27-31, greater than or equal to 81 years old, with stand heights between 16 and 20 metres, with a stand volume greater than 140 m^3/ha. Currently, there are a total of 186,940 ha of small pine in the THLB.

Immature aspen stands are less than 81 years old having a site index between 15.9 and 17.7 m. Currently, there are 76,761 hectares of immature aspen in the THLB. In TSR2, these immature aspen stands were not included in the base case THLB.

The DFAM group also reports that given current marketplace and processing infrastructure, harvest in small pine and immature aspen is also not currently economically viable.

In total, the exclusion of small pine, immature aspen and the Fort Nelson West areas reduces the base case THLB by 479,034 ha to 953,235 hectares (Table 23). The above three factors are also shown spatially in Figure 39.

Table 23: Area (ha) in the timber harvesting land base by small pine, immature aspen and Fort Nelson West

Pine	Aspen	Fort Nelson West	THLB (ha)
		X	215,333
	X		74,326
	X	X	2,435
X			33,993
X		X	152,946
186,940	**76,761**	**370,715**	**479,034**

The sum at the bottom of the table represents how much THLB is under each column or reduction factor. The 'X' shows where overlaps occur.

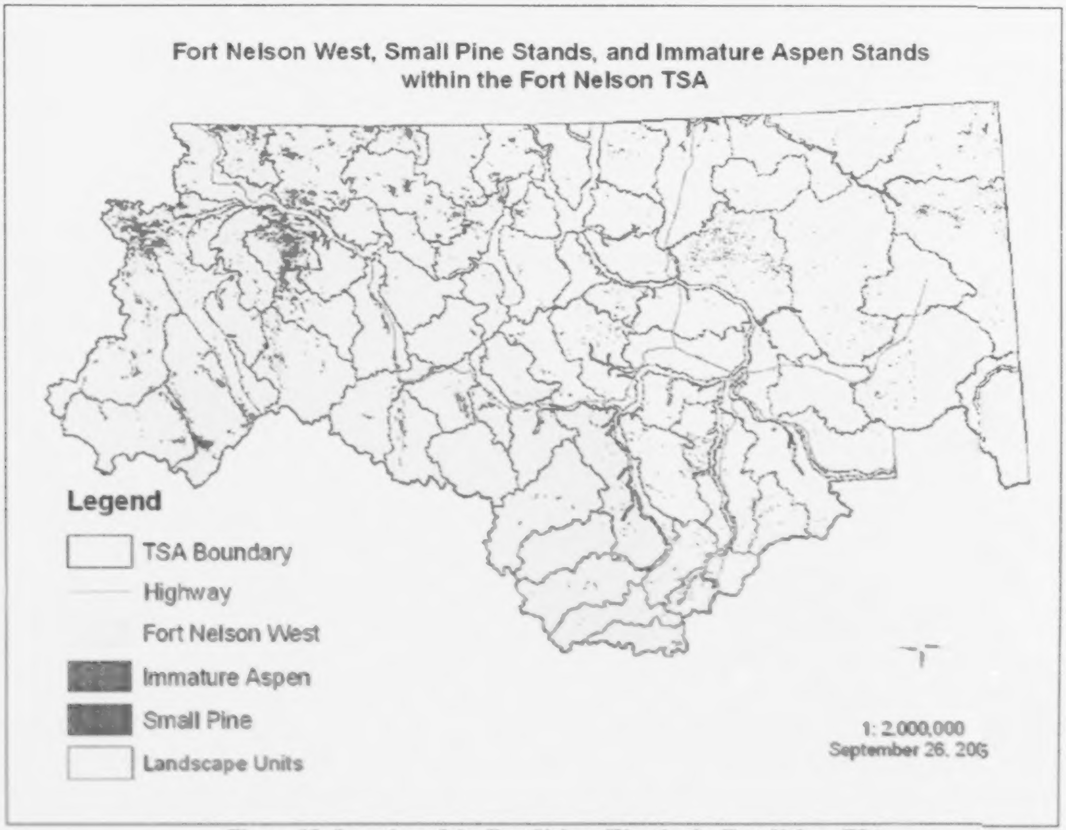
Fort Nelson West, Small Pine Stands, and Immature Aspen Stands within the Fort Nelson TSA
Legend
TSA Boundary
Highway
Fort Nelson West
Immature Aspen
Small Pine
Landscape Units
1: 2,000,000
September 26, 2005

Figure 39: Location of the Fort Nelson West in the Fort Nelson TSA

Over a 250-year forecast horizon, the maximum even flow harvest achieved for this scenario is 2,253,000 m^3/year or a 28.8% reduction from the base case harvest of 3,163,000 m^3/year. However, this scenario can sustain the base case harvest (3,163,000 m^3/year) for the first 15 years, followed by a 10% decline every 10 years before maintaining a long-term harvest of 2,253,000 m^3/year after 50 years (Table 24 and Figure 40).

Table 24: Harvest summary—no harvesting in the Fort Nelson West, small pines and low site immature aspen

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short-term Harvest (m^3/year)	Mid- and Long-term		
			Harvest from Sensitivity Analysis (m^3/year)	Chang from Base Case (m^3/year)	% Change
No harvesting in the Fort Nelson West, small pines and low site immature aspen	3,163,000	No change for the first 15 years	2,253,000 m^3/year from year 50 and onwards	-910000	-28.8%

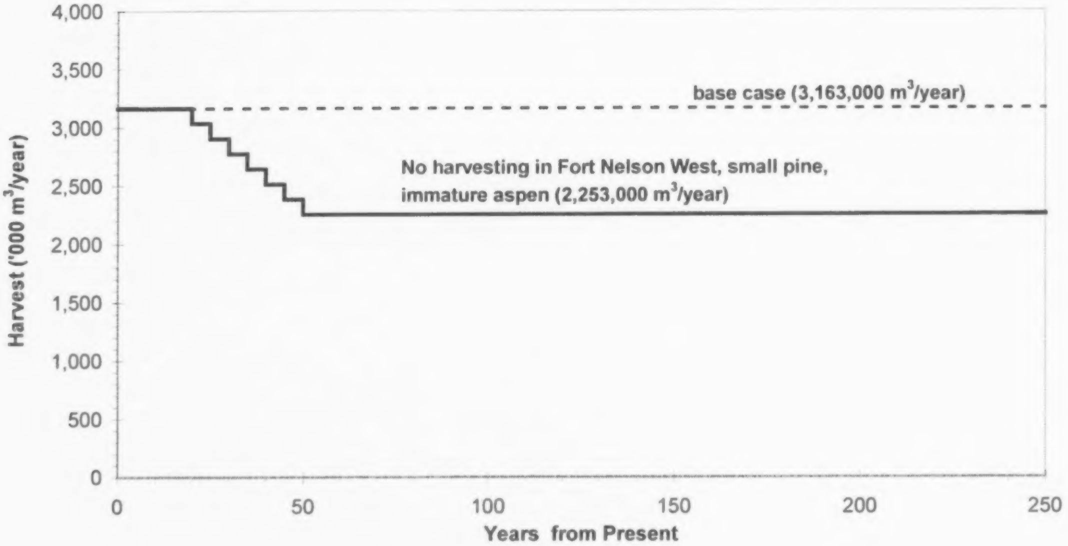

Figure 40: Harvest forecast based on the exclusion of Fort Nelson West and stands in small pine and immature aspen

In TSR 2, the THLB was 924,857 ha and the base case harvest even flow was 2,276,000 m^3/year. Under this 'Fort Nelson West-small pine-immature aspen' scenario, the THLB is about 3% larger than that of TSR 2 and the even flow harvest is about 1% less than TSR 2. Note that for this scenario the THLB area will be smaller if future WTPs were removed from the crown forested land base, as was done in TSR 2. Nonetheless, the results from this scenario indicate that the Fort Nelson West, small pine and immature aspen play a large role in the THLB increase and subsequent harvest forecasts in TSR 3 when compared to TSR 2. If harvesting is not feasible in these areas and stand types, medium- and long-term timber supply would be substantially lower than in the base case. In the short term, the flexibility in timber supply demonstrated in the alternative harvest flows (Figure 26) provides a buffer that allows the base case levels to be maintained for the first 15 years.

5.15 Uncertainty in forest cover requirements for visual quality objectives

Visual quality objectives (VQOs) are modelled based on forest cover requirements as outlined in the *Procedures for Factoring Visual Resources into Timber Supply Analyses*. To manage for VQOs, a percent denudation rule is applied in the timber supply model as a constraint. Percent denudation is the allowable proportion of a visual area that can be less than the visually effective green-up (VEG) height (refer to Section 18.2 in Appendix 4 for more details). A map of the VQOs in the Fort Nelson TSA is provided in Appendix 10.

Uncertainty about forest cover objectives may arise from:

- inventory and classification of land into visual quality classes and visual absorption capability[8];
- estimates of how well different disturbance limits meet visual objectives;
- estimates of how non-harvestable forest may contribute to visual quality;
- variations in timing of stand establishment; and
- uncertainties about height growth of regenerated stands.

In the Fort Nelson TSA, there is a total of 175,004 hectares (or 12.2%) in the THLB that are subject to a VQO. Of the total forested area with VQOs, 29% is within the THLB; therefore the non-harvestable forested areas contribute significantly to meeting visual management objectives. The modelling of large natural disturbance events on these non-harvestable forested areas may play a significant role in temporarily delaying the achievement of VQOs at certain points in the planning horizon.

Three sensitivity analyses were used to test the role of visual quality objectives in the base case:

- **Remove VQO constraints**—this sensitivity analysis indicates the total impact of all VQOs on the harvest.
- **Increase all VEG heights by 5 meters**—Base Case VEG heights range from 3 to 8.5 meters. This sensitivity analysis puts downward pressure on timber supply by increasing the time required for a visually sensitive stands to reach green-up.
- **Minimize percent denudation**—percent denudation is reduced to the lowest possible percent denudation for a given VQO category. This change creates downward pressure throughout the planning horizon because it reduces the allowable area that is below VEG height.

Removing the VQO constraints allows a 1.9% increase in the even flow harvest level (Table 25 and Figure 41). Using minimum percent denudation creates a 4% downward pressure on the long-term harvest level, but no change is required to the short- and medium-term harvest levels due to the large surplus growing stock. Similarly, a 5-metre increase in VEG height requires a 5% decrease in the long-term harvest level, but no change in the short- and medium-terms.

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[8] It should be noted that the original resultant dataset (completed in January 2004) contained the VQOs for the Fort Nelson TSA, including those in the Cassiar, but not the 1997 updates along the Alaska Highway and Klua Lakes. The latter areas have since been included into the resultant (December 2004) but where these areas overlap with the original VQOs, the VQOs in the Alaska Hwy/Klua Lake coverage took precedence.

Table 25: Harvest summary—changes in forest cover requirements for visual quality objectives

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short and Mid-term Harvest (m^3/year)	Long-term (≥ 130 years)		
			Harvest from Sensitivity Analysis (m^3/year)	Change from Base Case (m^3/year)	% Change
Remove visual quality objectives	3,163,000	3,224,000	3,224,000	61,000	1.9%
Increase visual green-up height by five metres	3,163,000	Same as base case for the first 125 years	3,001,000	-162,000	-5.1%
Apply the lowest allowable disturbance limit for each VQO	3,163,000	Same as base case for the first 125 years	3,035,000	-128,000	-4.0%

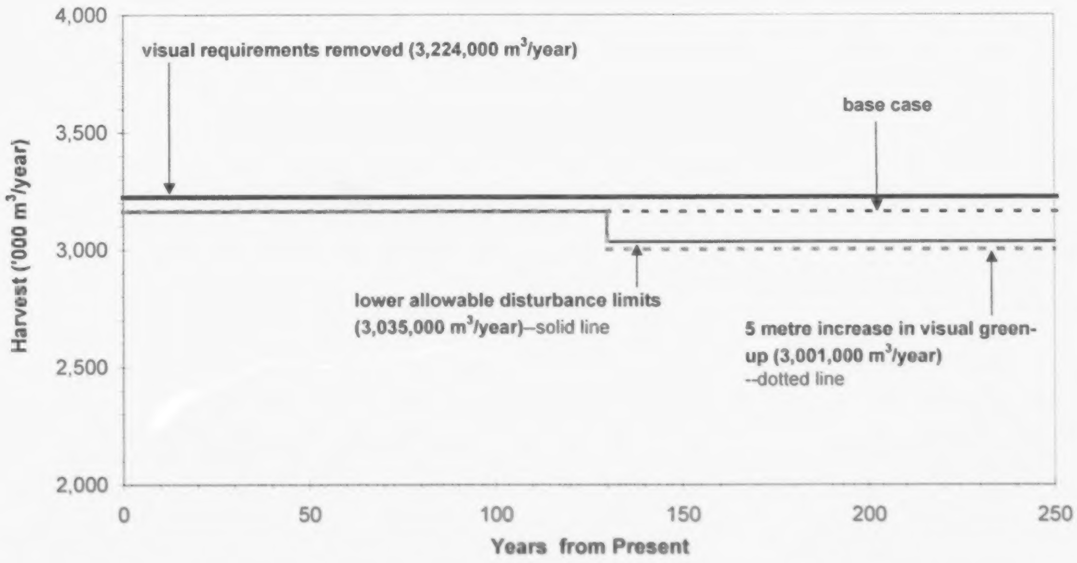

Figure 41: Harvest forecasts with different forest cover requirements for visual quality objectives (note change in scale)

5.16 Uncertainty in landscape-level biodiversity forest requirements

Restricting old forest contributions to the timber harvesting land base

In the base case, the landscape-level biodiversity requirements for mature and old forests are applied collectively to the THLB and the non-harvestable land base. Because the non-harvestable land base satisfies three-quarters of the forested land base, there is some uncertainty surrounding the amount of old forests that may be required for habitat objectives within the THLB.

A sensitivity analysis was completed to determine the extent to which the base case harvest levels are dependent on the NHLB contributions to biodiversity objectives. If landscape-level biodiversity objectives were applied only to the THLB, the long-term harvest level would decrease by 1% relative to the base case (Table 26). The short term is alleviated against this downward pressure and the base case harvest level can be maintained for the first 130 years.

Table 26: Harvest summary—changes in landscape-level biodiversity objectives (based on landscape units)

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short and Mid-term Harvest (m^3/year)	Long-term		
			Harvest from Sensitivity Analysis (m^3/year)	Change from Base Case (m^3/year)	% Change
Landscape biodiversity requirements are applied to the THLB only	3,163,000	Same as base case for the first 130 years	3,128,000	-35,000	-1.1%

Applying the natural range of variability concept

The landscape-level biodiversity objectives developed for the base case were developed using the concept of natural disturbance types (based on biogeoclimatic subzones) at the landscape unit level (as outlined in the *Landscape Unit Planning Guide*, 2000). However, in an April 2002 memorandum by the regional forest manager and regional director at the Ministry of Sustainable Resource Management licensees were encouraged to develop landscape-level plans using the guidance provided in the *Natural Disturbance Units of the Prince George Forest Region* document. The document was considered to be the best scientific information available pertaining to biodiversity management in northeastern BC. In this document, biodiversity management is based on the 'natural range of variability concept' and applied to natural disturbance units (NDUs), which are significantly larger in size than landscape units (LUs).

There are two NDUs in the Fort Nelson TSA: Boreal Plains and Northern Boreal Mountains as compared to the 85 LUs within the TSA. For the sensitivity analyses, the 85 LUs were merged to form nine aggregated LUs.

In the spring of 2004, the DFAM Group met with ecologists and planning officers from the Ministry of Forests, Ministry of Sustainable Resource Management, and Ministry of Water Lands and Parks to develop modelling assumptions and scenarios to address the NDU concept. The NDU concept has a definition for old forests classified by stand types (Table 27).

Table 27: Definition of old forests, based on the natural range of variation

Stand Type	Stand Type Description	Definition of Old
Conifer	≥ 80% conifer by leading species	>140 years
Deciduous	≥ 80% deciduous by leading species	>120 years
Mixed	conifer and deciduous leading species	>140 years

Three scenarios were chosen for sensitivity analyses:

1) **Scenario 1: Minimum natural range of variation**—Apply old forest targets (Table 27) based on minimum natural range of variation (NRV) for each natural disturbance subzone (Table 28). In addition, apply a minimum of 5% old forest target to each aggregated landscape unit. For example, in the Northern Boreal Mountains, the target would be a minimum of 37% of the CFLB must be in an old forest condition. Old forest is defined as being conifer-leading and mixedwood stands that are greater than 140 years old and deciduous-leading stands that are greater than 120 years old.

2) **Scenario 2: Mean natural range of variation**—Apply old forest targets based on mean NRV for each natural disturbance subzone (Table 28). In addition, apply a minimum of 10% old forest target to each aggregated landscape unit.

3) **Scenario 3: Aggregated landscape units**—Apply old forest targets based on minimum NRV to each aggregated landscape unit. For example, the Milo aggregated landscape unit, within the Boreal Plains Upland would require 17% of the CFLB in an old forest condition.

Table 28: Natural range of variation by natural disturbance subzones for Scenario 1 and 2

Natural Disturbance Units (Subzones)	Forested Area (ha)[1]	Scenario 1 (minimum NRV)	Scenario 2 (mean NRV)	Scenario 3 (minimum NRV)[2]
Northern Boreal Mountains	3,260,745	37.0%	48.5%	N/A
Boreal Plains (Upland)	2,363,121	17.0%	25.0%	N/A
Boreal Plains (Alluvial)	117,346	44.0%	50.5%	N/A
Aggregated Landscape Units	5,741,212	5.0%	10.0%	Apply minimum NRV (Scenario 1) based on NDU

[1] The resultant database used for this timber supply analysis was completed before information and spatial data were available for the NDU subzones and aggregated landscape units (LUs). Therefore, the NDU subzones and aggregated LUs were rated into the resultant based on a 50% rule (i.e. if a resultant polygon overlaps two aggregated LUs, the entire polygon will be assigned to the aggregated LU where the polygon has more than 50% of its area.)
[2] N/A=not applicable

To achieve old seral targets based on the minimum and mean NRV, the short-term harvest level must be reduced from base case harvest level (Table 29 and Figure 42). For the minimum NRV scenario, the harvest forecast begins at approximately 2,940,000 m^3/year and declines ten percent per decade until year 35 where the long-term harvest of 2,143,000 m^3/year is sustained. For the mean NRV scenario, the harvest begins at starts at 1,144,000 m^3/year and declines ten percent per decade until year 30 where the long-term harvest of 1,144,000 m^3/year is sustained. A possible reason for such a decrease in harvest level could be the old seral stage requirements for each natural disturbance subzone are higher than those modeled in the base case[9].

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[9] The mature and mature-plus-old seral targets based on LUs can be found in Table 93 of the data package. A quick comparison shows that the range of seral targets for LUs (depending on the biodiversity emphasis options) can range

For the aggregated landscape unit scenario, where minimum NRVs are applied to aggregated LUs rather than to NDU subzones, the base case harvest can be sustained for the first 10 years. After that, the harvest level would decrease ten percent every decade until year 35 where a long-term harvest level of 2,468,000 m^3/year can be maintained.

Table 29: Harvest summary—changes in landscape-level biodiversity objectives (based on natural disturbance units)

Sensitivity Analysis	Base Case Harvest (m^3/year)	Short-term Harvest (m^3/year)	Mid- and Long-term: Harvest from Sensitivity Analysis (m^3/year)	Mid- and Long-term: Change from Base Case (m^3/year)	Mid- and Long-term: % Change
Minimum natural range of variation are applied to natural disturbance subzones	3,163,000	Harvest starts at 2,940,000 m^3/year and declines approximately for 10% per decade till year 35	2,143,000 m^3/year from year 35 and onwards	-1,020,000	-32.2%
Mean natural range of variation are applied to natural disturbance subzones	3,163,000	Harvest starts at 1,489,000 m^3/year and declines approximately for 10% per decade till year 30	1,144,000 m^3/year from year 30 and onwards	-2,019,000	-63.8%
Minimum natural range of variation are applied to amalgamated landscape units	3,163,000	Same as the base case for the first 10 years	2,468,000 m^3/year from year 35 and onwards	-695,000	-22.0%

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from 11-16%, 13-19%, and 9-13%, for BWBSconifer, BWBSdeciduous, and SWB, respectively. For the NDU subzones, the minimum NRV requires an old target between 17-44%.

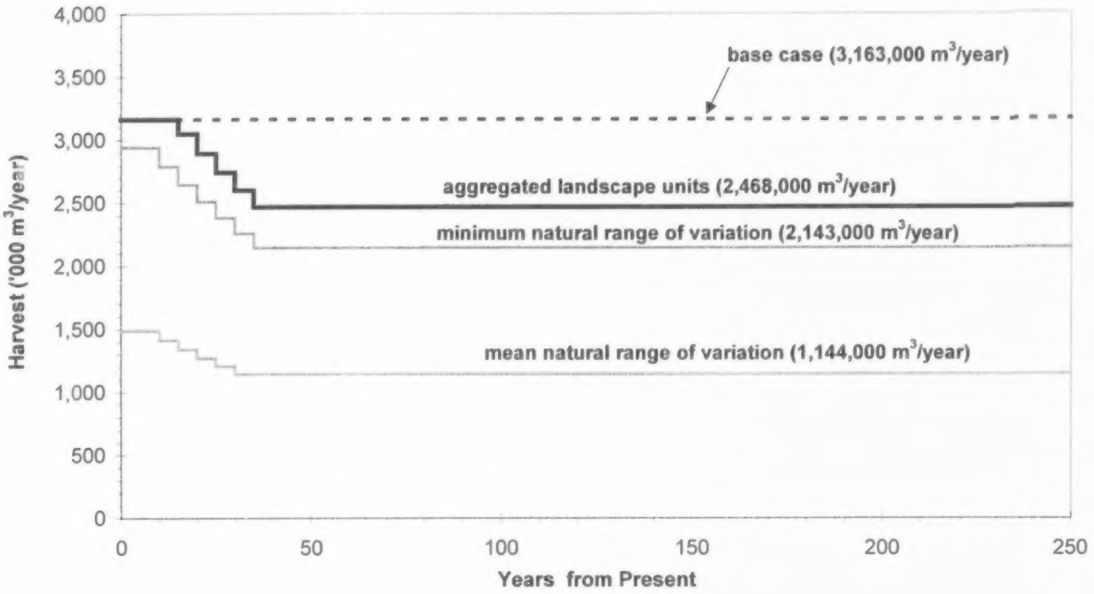

Figure 42: Harvest forecasts with different objectives of modelling on old forest cover requirements based on natural disturbance units

5.17 Summary of Sensitivity Analyses

A summary of the upward and downward pressure of each sensitivity analysis relative to the base case is presented in Table 30.

Table 30: Comparison of average timber supply from sensitivity analyses to the base case

Section	Issue	Sensitivity Analysis	Percent difference from base case harvest (year 1-130)	Percent difference from base case harvest (year 130-250)
5.2	Harvest Flow	Conifer harvest priority (alternative harvest 1)	No change	No change
		Elevated harvest flow 1	10.8% (23.0% first 55 years)	-0.03%
		Elevated harvest flow 2	12.7% (24.6% first 60 years)	-0.1%
		Random harvest rule	No change	No change
5.4	Land base	THLB is decreased by 10%	-0.3% (no change first 120 years)	-9.4%
5.5	Stand Volume Estimates	Existing stand yields are decreased by 10%	No change	No change
		Future stand yields are increased by 10%	11.0%	11.0%
		Future stand yields are decreased by 10%	-0.7 % (no change first 115 years)	-10.6%
5.6	Genetic Gain	Use of spruce seedlings with 20% genetic gain	5.9%	5.9%
		Use of spruce seedlings with 1% genetic gain	0.9%	0.9%
5.7	Minimum Harvest Ages (MHA)	95% of the maximum annual increment is applied as MHA	No change	No change
		Minimum harvest age is reduced by 20 years	No change	No change
5.8	Green-up Adjacency	Green-up height is increased by 5 metres	No change	No change
5.9	Stocking Class	Stands with incorrect projected stocking class were excluded from harvest	-0.03% (no change first 125 years)	-1.1%
5.10	Birch	Birch-leading stands may be harvested in the THLB	4.0%	4.0%
5.11	Small Pine	Small pines are excluded from the THLB	-0.5% (no change first 120 years)	-9.1%
5.12-5.13	Site Productivity	Use SIBEC	-0.1% (no change first 125 years)	-3.0%
		Use a higher minimum SI for immature stands	-0.4% (no change first 120 years)	-8.0%
		Use a lower minimum SI for immature pine	15.5%	15.5%
		Use a lower minimum SI for immature aspen	5.0%	5.0%
5.14	Operability	No harvesting in the Fort Nelson West, small pines and immature aspen	-21.1% (no change first 15 years)	-28.8%
5.15	Visual Quality Objectives	No visual quality objectives are applied	1.9%	1.9%
		Visual green-up height is increased by 5 metres	-0.2% (no change first 125 years)	-5.1%
		Apply lowest allowable disturbance limits	-0.2% (no change first 125 years)	-4.1%
5.16	Old seral objectives based on natural disturbance units	Minimum natural range of variation are applied to amalgamated landscape units	-18.6% (no change first 10 years; -22.0% after year 35)	-22.0%
		Minimum natural range of variation are applied to natural disturbance subunits	-29.0% (-32.2% after year 35)	-32.2%
		Mean natural range of variation are applied to natural disturbance subunits	-62.6% (-63.8% after year 30)	-63.8%
5.16	Biodiversity	Landscape biodiversity requirements are applied to the THLB only	-0.3% (no change first 125 years)	-1.1%

6 Conclusions and Discussions

One of the most important attributes of the base case harvest forecast is that it is constrained to an even flow. The alternative harvest forecasts provided in Section 5.2 demonstrated that there is at least a surplus volume of 50 million cubic metres that could be harvested in the short- and medium- terms, over and above the even flow harvest level. Foregoing this volume substantially reduces the risks associated with the short- and medium-term harvest levels.

The sensitivity analyses demonstrated that the surplus growing stock acts as a reserve that can be drawn upon in the event of downward pressures on timber supply. For example, a 10% reduction in the timber harvesting land base (Sensitivity 5.4) produced no timber supply impact until 120 years into the planning horizon. The large existing surplus volume helps mitigate against possible data and assumptions uncertainties. Nevertheless, the base case even-flow is selected over the alternative harvest flows as a more conservative approach, due to the continuing uncertainties surrounding the forest inventory data, operability and a newly adopted modeling methodology, which allows for a fluctuation in conifer and deciduous volumes over time.

This analysis report presents a base case harvest level of 3,163,000 m^3/year with an average coniferous harvest of 1,719,500 m^3/year and an average deciduous harvest of 1,443,500 m^3/year. However, for the first 35-years, there is enough flexibility in the harvest level to allow for a higher conifer and lower deciduous harvest. Since the analysis attempts to maintain a sustainable harvest level in the short-, medium- and long-term without a fall-down effect, the harvest flow is controlled by its long-term harvest level.

Visual quality objectives, green-up adjacencies, mature and mature-plus-old seral targets for were modelled through forest cover constraints in the base case analysis. The substantial amount of area in the non-harvesting land base (75% of the entire forested area in the Fort Nelson TSA) plays a critical role in achieving visual and old seral targets minimizing the dependency on the THLB. Generally, as forests in the non-harvesting land base age, they can contribute to forest cover constraints. However, in the event of large natural disturbances (or disturbing the NHLB as modelled in this analysis) the THLB could be constrained if there is not enough old forest to satisfy the seral requirement. In this situation, harvest does not take place in old stands or recruitment stands until the forest cover constraints for that resource emphasis area (e.g. landscape unit or visual quality polygon) are achieved. Likewise, when forest cover constraints are achieved any excess THLB that satisfies the minimum merchantability requirements could potentially be harvested.

In order to assess the impacts of potential changes to modelling and management assumptions on the base case harvest level and gain further understanding of the dynamics in the base case, several sensitivity analyses were completed. Based on the analysis, some of the factors and uncertainties that have a upward pressure on the harvest level for the Fort Nelson TSA include:

- Planting spruce seedlings with a genetic gain.
- Realizing higher net volumes from harvesting of future managed stands.
- Redefining operability by reducing the minimum site productivity thresholds for immature pine and aspen, and
- Harvesting of birch-leading stands.

Because of the surplus growing stock in the base case, most of the uncertainties that were tested had no harvest level impact in the short-and medium-term, which allowed for the base case harvest level to be maintained over the same period. The following factors exhibited a downward pressure in the long-term harvest level:

- Reducing the timber harvesting land base area,
- Reducing future stand yields,
- Excluding harvest in small pine stands,
- Using site index estimates based on site series (SIBEC) on conifer-leading stands in areas with Predictive Ecosystem Mapping (PEM) and Terrestrial Ecosystem Mapping (TEM),
- Increasing visual green-up height requirements,
- Redefining operability by increasing the minimum site productivity thresholds for all species immature stands, and
- Excluding harvest in the 'Fort Nelson West' area.

The modelling of biodiversity requirements based on natural disturbance units (rather than based on landscape units as in the base case) placed significant downward pressure on the base case harvest level throughout the short-, medium- and long-terms of the planning horizon.

The base case harvest forecast was insensitive to changes in the minimum harvest age, random versus relative oldest first harvest rules, and increases in green-up heights.

Although these sensitivities indicate that there is potential for the harvest forecast to change, the base case scenario is felt to best represent the potential timber supply in the Fort Nelson TSA. However, there are some factors that had limited data or information during the preparation of the data package, which may increase the uncertainty of the base case:

- The impact and extent of oil and gas activities on the forested land base is not well quantified. Although the best available data at the time was used: there are deficiencies in the location of seismic lines, lease sites, burrow pits and sumps, pipelines, and camp locations. Also, there is limited information available regarding the width of the seismic lines and the size of the pits, as well as documentation of the regeneration potential for these areas to form a commercial stand in the future is incomplete.

- The Phase 2 Vegetation Resources Inventory (VRI) identifies non-forests (such as lakes, wetlands, and rivers), and non-productive area (such as rocks and gravel pits), as a percentage of the inventory polygon. In the analysis, if greater than 50% of the inventory polygon is non-forested or non-productive, the entire polygon would be considered non-forested or non-productive and if less than 50%, the entire polygon was considered to be productive. It is uncertain whether this assumption over or underestimates the total area in non-forest or non-productive areas.

- Out of the 462,355 ha of spruce-leading stands in the THLB, 171,004 ha (37%) are labelled 'spruce' (or 'S' in VRI) and are generally in the 'rolled-over' areas in VRI. It is unclear whether these areas contain predominantly white or black spruce.

- The Visual Landscape Inventory used in the analysis contains the combined coverages of the 1995 broad mapping of visually sensitive areas in the district and the 1997 detailed visual landscape inventories for the Alaska Highway and Klua Lakes. Where the two coverages overlap, the Alaska Highway and Klua Lakes visual objectives take precedence as they have been formally established. In some situations, there are areas where only part of a VOQ polygon from the 1995 mapping overlaps with the 1997 mapping. It is uncertain whether the remaining non-overlapping area should remain as a visually sensitive area or not. These non-overlapping areas were left in the analysis and were modelled with a VQOs.

- The provincial Identified Wildlife Management Strategy, strategies for regionally important species, and caribou habitat areas have not been formally established and therefore were not accounted for in the analysis. Once implemented, these wildlife strategies may have an impact the timber supply.
- The modelling assumptions around natural disturbance in the non-harvesting land base may be too rigid as they are based on a stand age-reset rule, where stands are subjected to a disturbance at a given age and are not able to grow older than 119-280 years depending on the biogeoclimatic zone in which they occur.

Further study related to all of these uncertainties could improve confidence in future timber supply projections.

Additional uncertainties related to ability of the forest industry to economically harvest and process the timber in some areas and stand types was highlighted in the process of undertaking the timber supply analysis.

There is uncertainty about the economic viability of harvesting in areas west of the Dunedin operating area (Fort Nelson West), and in small pine stands and immature aspen stands, which collectively cover about one-third of the THLB. The uncertainty regarding the western portion of the TSA stems from a combination of factors including marketplace issues (e.g. market demand and prices, harvest and transport costs), lack of transportation infrastructure and the sheer distance to Fort Nelson where manufacturing facilities are located. For small pine and immature aspen, economic uncertainties stem from market place and processing infrastructure issues. A harvest flow comprised even and non-fluctuating contributions from coniferous and deciduous species harvest may be preferred in order to provide economic stability to the forest industry and the local community.

The DFAM group suggests that, although the base case harvest forecast provides an indication of the potential timber supply in the Fort Nelson TSA, current marketplace realities and the uncertainties around the base case identified in the sensitivity analyses should be carefully considered when determining the AAC.

- Approximately 86,000 hectares of not satisfactorily restocked (NSR) lands have resulted from wildlfires, are classified as non-productive, or are misclassified. These NSR areas were excluded from the THLB. For the next analysis, it would be useful to determine whether the NSR areas from wildfires would contribute to the THLB.
- Conduct additional stream classification studies to provide more certainty for riparian reduction assumptions within the Fort Nelson TSA.

- For those PEM or TEM projects without an accuracy assessment, conduct appropriate ground sampling and accuracy tests. Compare to the inventory data to determine whether site indices have been over or under-estimated.
- Conduct VRI Phase 1 and 2 projects to provide more certainty around the species type (e.g. white and black spruce), and volume adjustments. The previous Phase 2 project indicated that compared to the Phase 1 VRI data, volumes were overestimated in black spruce, lodgepole pine, larch, and white spruce stands whereas volumes were underestimated in cottonwood, aspen and birch stands. Currently VRI Phase 1 and 2 projects cover only approximately one third of the timber harvesting land base.
- Compile a complete visual landscape inventory for the next analysis.
- Conduct further analysis on managing biodiversity based on the natural disturbance unit and the natural range of variation concept.
- Develop old growth management areas.
- Monitor areas harvested in small pine stands.
- Refine estimates of physical and economic operability for the TSA. Consider identifying operability by supply blocks.

7 Socio-economic Analysis for the Fort Nelson TSA

The impact of timber supply and its adjustments on local communities and the provincial economy is an important consideration in the timber supply review. The socio-economic analysis investigates these relationships and compares the effect of forestry and related activities currently supported by timber harvested from the Fort Nelson TSA to the level of activity that the TSA could support based on the base case timber supply forecast. The socio-economic analysis includes the following:

- A profile of the current socio-economic settings,
- A description of the Fort Nelson TSA forest industry, and
- An analysis of the socio-economic implications of the base case harvest forecast.

8 Current Socio-economic Setting

This section describes the current population, demographics and employment profile in the Fort Nelson TSA.

8.1 Current population and demographic trends

Communities in the Fort Nelson TSA include the town of Fort Nelson and smaller unincorporated areas such as Prophet River, Toad River, and Muncho Lake. Unlike population growth in the early 1990's, the late 1990's showed a decline in population. According to the 2001 Census, the population of the Northern Rockies Regional District (NRRD) was 5,969, reflecting a decrease of 2% from the 1996 levels of 6,115 (Table 31). The Fort Nelson municipal population also decreased by 5% between 1996 and 2001 to 4,371 from 4,603. However, it is predicted that the population of the town of Fort Nelson will grow to 4,694 by 2004. Positive population growth of 11.92% has been predicted for the entire NRRD as well over the next decade, which is on par with the provincial average growth rate of 12.09%[10].

Table 31: Population estimates and trends in the Fort Nelson TSA and selected communities

	1996	2001	2004	2005	% change 1996 - 2001	% change 2001 - 2004
Town of Fort Nelson	4,603	4,371	4,694	4,834	-5.04	7.39
Unincorporated areas	1,512	1,598	1,740	1,767	5.69	8.89
Northern Rockies Regional District	6,115	5,969	6,434	6,602	-2.39	7.79
British Columbia	3,874,276	4,078,447	4,196,383	4,239,064	5.27	2.89

Data Source: BC Stats. Numbers are population estimates and include net Census undercount. 2005 population estimates were based on the 10.6% projected growth for the NRRD between 2001 and 2005 (P.E.O.P.L.E. 30), which was applied to determine the population in the Town of Fort Nelson and Unincorporated areas.

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[10] Over the 2005-2015 period, the population projection for the Northern Rockies Regional District used a growth rate of 11.92%, which is comparable to the 12.09% growth rate projected for the province. (Population for Organizational Planning with Less Error or P.E.O.P.L.E. 29, BC Stats).

There are eight First Nations that are resident or have traditional territory within the Fort Nelson TSA: Fort Nelson First Nation, the Dene Tsaa Tse K'Nai First Nation, Dena Tha' First Nation, Fort Liard First Nations, Lower Post First Nation, Dease River First Nation, Halfway River First Nation and Tahltan Indian Band. These communities have in total more than 6,000 members; however, the number of members actually residing in the TSA is a lot less and is not well known (Table 32). In the 2001 Census, it was estimated that 490 people lived in Indian reserves in the Fort Nelson TSA and 470 aboriginal people lived in the town of Fort Nelson (or 11.2% of the town's population).

An informal phone survey on First Nations employment in the TSA was conducted in October 2005. The four mills in the TSA employs directly or through contractors approximately 47 First Nations people with a few contracted for silviculture work or archaeological impact assessments. In addition, 11 first First Nations are employed in field work for Canfor.

Table 32: Estimated population of First Nations that have at least part of their community in the Fort Nelson TSA

First Nation Community	Population	Currency of Data
Fort Nelson First Nations	Approximately 750 members	2005
Prophet River Band, Dene Tsaa Tse K'Nai First Nation	Approximately 200 members	2004
Liard First Nations (Yukon)	Approximately 1,030 members	2005
Dene Tha' First Nations (from Assumption, Alberta)	Approximately 2,440 members	2005
Dease River (Good Hope Lake)	Approximately 165 members	2005
Tahltan Indian Band (Dease Lake and Telegraph Creek 6, Guhthe Tah)	Approximately 1,580 members	2005
Halfway River First Nations	Approximately 220 members	2005

Data Source: 1) Dept of Indian Affairs and Northern Development. Registered Indian Population by Sex and Residence 2004. 2) Dept of Indian Affairs and Northern Development . First Nations Profile Database.:Registered Population as of September 2005

8.2 Economic profile

8.2.1 Labour force

From 1996 to 2001, the total labour force in the Fort Nelson TSA grew by 9% to 3,508 from 3,196 (Table 33). The labour force in the basic sector however, grew by 12% in the same period[11]. The basic sector includes the forestry, mining, fisheries, tourism, agriculture, public sector, and construction industries. In 2001, the basic industries contributed $89.3 million in income[12] to the Fort Nelson TSA, which is a 41% increase from 1996 of $63.4 million. The non-basic sector relies on the basic sector by selling goods and services to them. Overall, the non-basic sector accounts for 17% of the total labour force and 14% of the total income earned by the working labour force.

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[11] Income from the basic sector is income that flows into the community usually in response to goods and services produced in the community and exported from it. The non-basic income is paid to individuals in the community for goods and services they provide to other individuals in the community or to the basic sector (e.g retail outlets, grocery stores)

Forestry is the largest sectoral employer in the Fort Nelson TSA, accounting for 27% of all employment, followed by the public sector (22%), mining (19%), and tourism (16%), as shown in Figure 43. Forestry is also the highest paying sector with workers earning an average of $41,276, followed by mining ($33,818) and construction ($32,432). The majority (83%) of the jobs in the forest sector are from wood manufacturing in the three mills operating in the TSA. The remaining jobs include those in harvesting, transportation, planning, and silvicultural operations (Table 34).

Table 33: Employment and income of the labour force

	1996 Employment (person)	2001 Employment (person)	% Change in Employment	1996 Income ($millions)	2001 Income ($millions)	% Change Income ($millions)	Average Income ($)
Forestry	1,132	768	-47.4	31.1	31.7	1.9	41,276
Mining	131	550	76.2	3.5	18.6	81.2	33,818
Fish & Trapping	8	11	27.3	0.0	0	N/A	N/A
Tourism	432	474	8.9	6.2	7.5	17.3	15,823
Agriculture & Food	20	39	48.7	0.0	0.7	100.0	17,949
Public Sector	449	641	30.0	10.8	17.4	37.9	27,145
Construction	245	185	-32.4	6.4	6	-6.7	32,432
Other	186	250	25.6	5.4	7.4	27.0	29,600
Non Basic	593	589	-0.7	12.5	16	21.4	26,995
Transfer Payments				4.9	6.8	27.9	
Other non-employment income				1.1	5	79.2	
Total	**3,196**	**3,508**	**8.9**	**82**	**117.3**	**30.2**	

BC Stats. 1999 and 2004a. Income is based on after-tax total income from direct and indirect income sources. Average income was calculated by total income ($) divided by employment (person) for 2001.

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[12] Basic income includes both employment income (e.g. in the form of wages and salaries) and non-employment income (e.g. transfer payments from government such as welfare payments, old age securities, and employment insurance as well as investment income such as dividends and interest, retirement pensions, and alimonies).

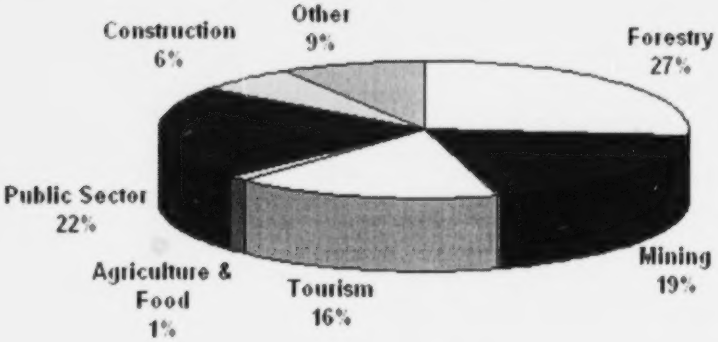

Figure 43: Experienced labour force by basic sector in the Fort Nelson TSA, 2001

Table 34: Employment and income in the forest industries

	2001 Employment			2001 Income ($Millions)		
	Basic	Non-basic	Total	Basic	Non-basic	Total
Logging	132	28	160	4.6	0.7	5.4
Wood Manufacturing	636	159	796	27.0	4.3	31.3
Total:	**768**	**187**	**956**	**31.6**	**5.0**	**36.7**

BC Stats. 2001a

While the forestry sector also directly supports 32% of the non-basic employment, employment in forestry has decreased by 47% from 1996 to 2001. During the same period employment in mining and agriculture has increased by 76% and 49%, respectively. The 47% decrease in the forestry sector may appear high but it does coincide with the Canadian Chopstick Manufacturing Company shutting down in 1997, which supported about 215 full-time equivalent jobs. It is also likely that the silvicultural contractors have downsized since there is less silviculture work being conducted in backlog reforestation and non-commercial brush conversions programs have decreased significantly. Overall, employment levels with the Canadian Forest Products Ltd. (Canfor) have remained stable over the same period.

The oil and gas sector is the second largest industrial sector in the region. Figure 43 excludes employees who reside outside of the Fort Nelson TSA, and as such the actual role of the oil and gas industry in the TSA is not well reflected in this figure. Activities in the sector include those in natural gas processing and ongoing exploration and development of new reserves.

Duke Energy (formerly, the WestCoast Energy Inc.) is the second largest private sector employer in the town of Fort Nelson after Canfor[13]. Duke Energy operates a natural gas processing plant in Fort Nelson, including an office/pipeline yard just north of town and a smaller facility in Patry Lake[14]. Other facilities in the region include those in Sikanni and Cabin Lake. In the entire region, Duke Energy employs approximately 130 people with roughly 90 people in the Fort Nelson plant and 30 people in the northern office. The majority of the employees reside within the TSA.

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[13] Top 10 Private Sector Employers. Fort Nelson and Northern Rockies Regional District. (http://www.northernrockies.org/Departments/EcDev/econ_devel_5largest.htm). Feb. 25, 2005.

[14] Phone correspondence with Mark Jenkins, Area Director of Duke Energy Gas Transmission Fort Nelson. Feb. 25, 2005. (Phone: 250-233-6200)

Other top employers in the TSA that provide oil and gas services include: D&B Oilfield Contracting, Eh-Cho Dene Enterprises, Kledo Construction, Doug Gordon Contracting and Streeper Contracting[15]. The oil and gas sector contributes indirectly to the forest industry through timber harvesting required for exploration and maintenance activities (e.g. seismic lines).

In 2001, the public sector had an estimated 641 employees. The largest employers in the public sector are School District #81, the Fort Nelson general hospital, the municipality/ Northern Rockies regional district office in Fort Nelson, and the Northern Lights College. The Ministry of Forest district office has 30 employees, of which 3 are BCTS staff[16].

The unemployment rate for the Northeast Development Region[17] increased from 5.9% in 2001 to 6.9% in 2003. In 2001 the region had the second lowest unemployment rate of the province's nine development regions. The employment rate in the region is the highest in the province at 71.4%. In general, the unemployment rate in the region is below the average for the province. The employment rates in logging and support activities for forestry are 57% and 89%, respectively[18].

Linda Wallace, Director of Economic Development and Tourism Services for Fort Nelson and the Northern Rockies, describes the economy of Fort Nelson as[19]:

> Over the past five years, the economy in Fort Nelson has strengthened considerably, with changes to the oil and gas sector driving new business and population growth. The Canfor forest products operations remain the largest single employer for the community, however oil and gas companies and the companies that serve that sector have grown substantially since 2002. New business starts have been between 10% and 15% annually for the past two years and business expansions have also accounted for considerable increases in employment numbers for the community. The economic base can be described as extremely robust, and the community is feeling the challenges of growth, especially in terms of housing demand (and, therefore, cost of housing) and in terms of stress on infrastructure such as roads, water and sewer.
>
> Unemployment rates for Fort Nelson are traditionally very low. At the time of the 2001 census 93% of income came from wages, with only 5% coming from "government transfers" of any kind (Employment Insurance, social assistance, pension, and other). While we have no data available to demonstrate it, it is assumed that the income from wages is even higher today than as at that last

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[15] Reference same as Footnote 5.

[16] Email correspondence with Bob Krahn, district stewardship forester. March 7, 2005.

[17] The Northeast Development Region is comprised of the Fort Nelson Forest District, and the Dawson Creek, Fort St. John, and part of the Mackenzie forest district.

[18] Requested data from Stats Canada, customized report on employment in the Northern Rockies Regional District. The employment rate for logging may be low because logging predominantly occurs in the winter months and not year round.

[19] Written (email) statement was provided by Linda Wallace on July 5, 2005.

census. It should be noted that the provincial number for income from wages in 2001 was only 75%.

8.2.2 Local area dependency

The employment percentages presented in Figure 43 do not reflect income levels or the dependence of one sector on the spending of another. For example, the forest industry may make local purchases of goods and services that lead to employment in other sectors. These goods and services may be supplies from retail stores, consultation with accountants and lawyers, or contracts with other tradesmen for special jobs, which forest industry employees are not trained to handle. Generally, sectors with higher incomes and spending levels tend to purchase more goods and services and, therefore support more business activities and higher levels of employment.

Employment multipliers illustrate this spending effect. A larger multiplier indicates that the business activity supporting each direct job will subsequently support more business activity at supply and service companies. For example, estimates by the Ministry of Management Services, indicate that every 100 full-time direct forestry jobs in the Fort Nelson TSA support another 25 to 35 indirect and induced jobs within the TSA, depending on whether the forestry jobs are in logging or wood manufacturing (Table 35). Every 100 mining, oil and gas jobs support an additional 34 positions. In contrast, every 100 public sector jobs support 19 indirect and induced jobs, and every 100 tourism jobs support 12 additional jobs.

Table 35: Fort Nelson TSA employment multipliers

	Indirect and Induced Employment Ratio	Indirect Employment Ratios
Logging	1.25	1.15
Wood Manufacturing	1.35	1.20
Mining	1.34	1.25
Agriculture	1.17	1.11
Tourism	1.12	1.09
Public Sector	1.19	1.13
Construction	1.22	1.14

BC Stats. 2001a. The indirect and induced employment ratio assumes no migration with safety net in place.

Other indicators of economic well being in the TSA are the Diversity Index and the Forest Vulnerability Index. The Diversity Index is based on the economic dependencies among 11 sectors and is zero if the area were entirely dependent on one sector and 100 if a local area were equally dependent on each of the defined sectors. The premise is that a more diversified economy will provide more community stability in volatile economic times. The Diversity Index for the Fort Nelson TSA for 2001 is 68, which is up from 56 in 1996 illustrating that the economy is becoming more diversified. The diversity indices for BC communities range from 29 to 75 with the average being 65; therefore, the diversity index for the TSA is slightly above average for BC. (BC Stats. 2004b)

The Forest Vulnerability Index is a relative number and indicates the vulnerability of each local area to potential downturns in the forest sector. It is set to 100 for the most vulnerable area (Port Hardy) and to 0 for the least vulnerable area (Victoria). The Fort Nelson TSA has a Vulnerability Index of 43, which is down from 85 in 1996, but up from 37 in 1991. The Vulnerability Indices for the forest districts in BC range from 3 (the Chilliwack Forest District) to 223 (the Mackenzie Forest District). The Fort Nelson Forest District is the tenth most vulnerable forest district out of the 29 existing forest districts.

In general, the Fort Nelson economy is relatively healthy and relies heavily on the forest and oil and gas industries. It is expected that both of these sectors will continue to maintain and, if not increase the employment level in the area, continue supporting a significant number of indirect jobs.

9 Fort Nelson TSA Forest Industry

9.1 Current allowable annual cut

The current allowable annual cut (AAC) in the Fort Nelson TSA was set in September 2001, at 1,500,000 cubic metres per year (600,000 cubic metres from coniferous-leading stands and 900,000 cubic metres from deciduous-leading stands) (Table 36), which is unchanged from 1995. Prior to 1995, the AAC was set at 972,000 cubic metres per year (750,000 cubic metres from coniferous-leading stands and 222,000 cubic metres from deciduous-leading stands). The apportionment of the current AAC has changed on March 31, 2005 with the enactment of the Take-back in the provincial Revitalization Plan (i.e. 20% of the provincial AAC from replaceable forest licences have been re-apportioned to BCTS, First Nations, woodlots and community forest licences). Prior to the take-back, the apportionment of the AAC is shown in Table 36 and the new apportionment of the AAC is shown on Table 37.

Table 36: Fort Nelson TSA annual allowable cut, apportionment and commitments (prior to 03/31/2005)

Form of Agreement	Conventional		Deciduous-leading		Total	
	m^3	%	m^3	%	m^3	%
Forest Licence – Replaceable Canadian Forest Products Ltd.	538,973	89.93	134,743	14.97	637,716	44.91
Pulpwood Agreement - Timber Sales Licences Canadian Forest Products Ltd.			610,000	67.78	610,000	40.67
BCTS - Timber Sale Licence/ Licence to Cut	59,427	9.9	144,241	16.03	203,668	13.58
Woodlot Licence	1,600	0.27	400	0.04	2,000	0.13
Forest Service Reserve			10,616	1.18	10,616	0.71
Total:	**600,000**	**100**	**900,000**	**100**	**1,500,000**	**100**

Effective Date: 09/01/2001-03/30/2005. Determination Date: 05/24/2001.

Table 37: Current Fort Nelson TSA annual allowable cut, apportionment and commitments

Form of Agreement	Conventional		Deciduous-leading		Total	
	m^3	%	m^3	%	m^3	%
Forest Licence – Replaceable Canadian Forest Products Ltd.	442,973	73.83	110,743	12.30	553,716	36.91
Pulpwood Agreement - Timber Sales Licences Canadian Forest Products Ltd.			610,000	67.78	610,000	40.67
BCTS - Timber Sale Licence/ Licence to Cut	136,227	22.70	163,441	18.16	299,668	19.98
Woodlot Licence	1,600	0.27	400	0.04	2,000	0.13
Forest Service Reserve			10,616	1.18	10,616	0.71
Small Tenures (woodlot and community forest licences)	19,200	3.20	4,800	0.53	24,000	1.60
Total:	**600,000**	**100**	**900,000**	**100**	**1,500,000**	**100**

Effective Date: 03/31/2005

9.2 Harvest history

The actual volume of timber harvested is an important indicator of forestry and economic activity in the TSA. The volume of timber harvested in the Fort Nelson TSA from 2000 to 2004 is shown in Table 38. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year determines the level of economic activity. Differences in annual harvest levels and AAC may occur due to certain operating and market conditions. If actual annual harvest levels are consistently less than the AAC, then forestry activity is below its full potential.[20]

In 2004, 1.44 million cubic metres were harvested from the Fort Nelson TSA, up from 1.39 million cubic metres in 2003[21]. From 2000 to 2004, the average annual harvest volume in the TSA was 1.36 million cubic metres totalling approximately $5.37 million in stumpage annually. Over the same period, approximately 90% of the total harvest volume was from forest licences and timber sale licences, 6% from BCTS, and less than 1% from woodlots. However, the distribution of harvest volume from the various tenures is changing with the implementation of the provincial government's Forestry Revitalization Plan. On average 20% of the replaceable licences are returned back to the Crown and redistributed to provide opportunities for First Nations, community forests, and woodlots.

Over the 2000-2004 period, about 59% of the total harvest was from deciduous species, reflecting the demand of deciduous species for processing in the Canfor's oriented strand board plant. Over the same period, the share of coniferous species as a percentage of the total harvest has fluctuated between 34% and 46%.

Table 38: Volumes billed by licence type, 2000-2004

Licence Type	**2000**	**2001**	**2002**	**2003**	**2004**	**Average 2000-2004**
Forest licence	570,444	972,245	888,676	661,168	720,025	762,512
Pulpwood Agreement-Timber Sales licences[1]	501,714	287,401	474,972	616,445	452,071	466,521
BC Timber Sales	31,501	24,478	82,911	96,607	188,617	84,823
Woodlot licence	419		1,573			996
Other[2]	48,937	27,270	32,813	16,054	80,204	41,056
Total Volume Billed:	**1,153,015**	**1,311,394**	**1,480,945**	**1,390,274**	**1,440,917**	**1,355,908**

1 The volumes reflect Canfor's oriented strand board plant.

2 Other consists of cutting permits such as rights-of-way, road permits, and other small temporary permits.

Source: Requests from the harvest billing system, MoF (http://www.for.gov.bc.ca/hva/hbs/index.htm)

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[20] Full potential referred to here is based on the allocated volumes of the AAC, and is not necessarily the same as full economic potential which is based on the international market for wood products.

[21] The volume harvested and the amount billed by the licensees was requested through the Ministry of Forest's harvest billing system (http://www.for.gov.bc.ca/hva/hbs/index.htm).

9.3 Fort Nelson TSA major licencees

In the Fort Nelson TSA, the major licencees are Canadian Forest Products Ltd. (Canfor) and BC Timber Sales (BCTS). There is also one active woodlot in the TSA.

9.3.1 Canadian Forest Products Ltd. (Canfor)

Canfor acquired Slocan Forest Products Ltd. in November of 2003, creating the largest producer of softwood lumber and one of the largest producers of northern softwood kraft pulp in Canada. Canfor has tenures throughout the province with a total AAC of almost 14 million cubic metres or 17.6% of the provincial AAC. In the Fort Nelson TSA, Canfor has a replaceable forest licence to harvest 553,716 cubic metres per year, 90% of which comes from coniferous stands. Canfor also has a pulpwood agreement for an annual volume of 610,000 cubic metres of deciduous fibre. Canfor's recent Fort Nelson TSA harvest history and average employment statistics are shown in Table 39.

Table 39: Canfor Fort Nelson TSA volumes billed and employment statistics

Harvest	**Volume m^3**
Allowable annual cut (set in 2001)	1,247,716 m^3
Allowable annual cut (set in 03/31/2005)[1]	1,163,716 m^3
2004 volumes billed	1,172,096 m^3
2000-2004 average volumes billed	1,229,033 m^3
Value	**$**
2004 value of volumes billed	$3,592,268
1999-2004 average value of volumes billed	$2,286,449
Employment (2004)	**Person-Years**
Harvesting and administration	141
Transport, road building and maintenance	159
Silviculture	143
Timber Processing	618
Total	1,061

Employment is based on provincial statistics (activities in and outside of the TSA)

[1] The allowable annual cut reflects the cut after the enactment of the provincial 'take-back'

Canfor operates 19 sawmills in BC, including the three major mills in the Fort Nelson TSA: a sawmill, an oriented strand board (OSB) plant, and a veneer/plywood mill. All of the timber harvested in the TSA by Canfor is also processed in the TSA. Canfor's Fort Nelson TSA licences supply the local mills with approximately 83% of their timber requirement; the remainder comes from the Fort Nelson BCTS tenure, private, and sources outside the Fort Nelson TSA.

In 2004, the Tackama lumber mill processed approximately 171,000 cubic metres of timber; the veneer/plywood mill processed 451,000 cubic metres, and the oriented strand board mill, processed 802,000 cubic metres of timber. The Canfor sawmill produces mostly stud lumber from conifer species. As of August 2005, the sawmill has been shut-down and may re-open if markets improve. There were no job losses as sawmill staff were transferred to the plywood mill and filled vacancies. The veneer/plywood mill processes coniferous and deciduous species while the OSB plant processes primarily deciduous species. The estimated annual capacity and the year these mills were established are listed in Table 40. The three mills employed about 680 people in 2004, up from 540 people in 1998.

Table 40: Canfor mills in the Fort Nelson TSA

Mill Type	Year of Establishment	Estimated Annual Output Capacity in 2003
Sawmill	1975	82 million board ft.
Oriented Strand Board	1996	504 million sq. ft. 3/8"
Veneer/Plywood	1984	180 million sq. ft. 3/8"

Source: Ministry of Forests (2004). Major Primary Timber Processing Facilities in British Columbia 2003.

In 2004, Canfor Fort Nelson exported 70% of its lumber and 76% of its oriented strand board production to the United States. Also in 2004, 95% of its plywood production was shipped within Canada.

9.3.2 BC Timber Sales

BC Timber Sales is apportioned 163,441 m^3/year from deciduous-leading stands and 136,227 m^3/year from conifer-leading stands, or 20% of the current AAC[22]. From 2000 to 2004, the annual harvest under BCTS averaged approximately 84,823 cubic metres. In 2004-2005, approximately 12% of the timber harvested under BCTS (25,000 cubic metres of deciduous species) is processed at the Four River Hardwoods mill. The remainder is processed at one of Canfor's Fort Nelson Mills. In 2004, BCTS supported approximately 117 person-years of employment through direct harvest, log transport, and silviculture jobs.

9.4 Forestry sector employment and employment coefficients

The preceding harvesting and employment information is used to develop employment coefficients, which are used to project future employment levels in the forestry sector. For this purpose, the forestry sector has been divided into three sub-sectors:

- harvesting and other woodlands-related employment including falling, log transport, log salvage, log scaling, harvest planning and administration;
- silviculture employment such as planting, surveying, and other basic and intensive silviculture activities, such as spacing, fertilizing and pruning; and,
- primary timber processing employment at lumber mills, OSB mills, and veneer and plywood mills.

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[22] Prior to the timber-reallocation (i.e. before 03/31/2005), BC Timber Sales was apportioned 144,241 m^3/year from deciduous-leading stands and 59,427 m^3/year from conifer-leading stands, or 13.6% of the current AAC.

9.4.1 Harvesting and silviculture employment

The harvesting component of the forest industry includes both company and contract loggers and is closely tied to the AAC. Consequently, any harvest level changes will affect this sub-sector the most. The predominant silviculture system used in the Fort Nelson TSA is clearcut using feller bunchers, some hand falling, and skidders. The majority of the harvesting takes place during the winter months, although summer logging does occur on a limited basis. Approximately 40% of the harvesting workforce resides in the Fort Nelson TSA and the remaining 60% comes from forest districts to the south or from other provinces.

Silviculture activity is split into basic and enhanced work. Basic silviculture consists of surveys, site preparation, planting, brushing, cone collecting and some spacing. Enhanced silviculture includes spacing, fertilizing, and pruning. Within the TSA, licensees are responsible for basic silviculture on areas harvested under Forest Licences. The provincial government is responsible for the remaining basic and all enhanced silviculture on Crown land, which is normally completed by silviculture contractors. Approximately 95% of the silviculture workforce currently comes from outside the Fort Nelson TSA.

The *TSR 2 Socio-economic Analysis for the Fort Nelson TSA* (2000) found that between 1996 and 1998, the average harvest of 1,372,800 cubic metres supported approximately 483 person-years of direct harvesting and silviculture employment. Data compiled for this timber supply review indicate that in 2004, 402 person-years are supported by this same employment at a harvest level of 1,444,900 cubic metres. The employment reduction over these two periods is partly contributed by the operational shutdown of the Canadian Chopsitck Manufacturing Company (CCMC) in 1997; the CCMC forest licence supported approximately 30 to 40 person-years of direct harvesting and silviculture employment.

9.4.2 Processing employment

The Fort Nelson TSA harvest supports processing employment not only in the Fort Nelson TSA, but also in other TSAs where timber and residual chips are shipped and processed. All of the timber harvested in the Fort Nelson TSA under the BCTS and Canfor's tenures remains in the TSA and is processed at one of the five mills[23]. This supply provides Canfor's Fort Nelson operations with approximately 95% of its requirements. Some of the timber from BCTS's operating area is also processed in the TSA by Trans North Timber and Four Rivers Hardwood. Residual coniferous chips produced at Canfor's local mills are shipped to the Fibreco pulp mill in Taylor, just south of Fort St. John. The majority of deciduous chips and logs are processed at Canfor's Fort Nelson oriented strand board plant.

Trans North Timber employs 11 full-time employees (including one First Nations) and produces rough cut lumber[24]. The mill has been in operations for 30 years. They process approximately 15,000 cubic metres annually, of which 70% are from spruce and 30% from cottonwood and aspen. However, Trans North Timber has the capacity to process 100,000 cubic metres and cite high BCTS bid prices and the lack of a forest licence as obstacles.

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[23] Four mills after the shutdown of Canfor's sawmill in August 2005.

[24] Information about Trans North Timber were provided by Leonard Peterson (operations manager) and Patricia Dell (office manager) through a phone interview on October 13, 2005.

Four Rivers Hardwood has been in operations for four years and produce rough lumber from aspen and spruce species. The volume harvested and the number of people employed has varied over the past few years but currently, employs two persons and are targeting 15,000 board feet this year. Approximately 90% of the lumber produced by Four Rivers Hardwood is sold in BC.

In 1996-1998, the previous AAC of 1,372,800 cubic metres supported approximately 621 person-years of direct processing employment across the province. Data collected for this review indicate that in 2004, the harvest of approximately 1,440,900 cubic metres supported a similar average employment level of about 648 person-years for the province. The direct processing employment within the TSA is 631 persons-years in 2004, which has increased from 497 person-years in 1996-1998.

9.4.3 Forest Service employment

The Fort Nelson TSA is administered by the Fort Nelson Forest District office located in Fort Nelson. Currently 30 people work in the forest district office and include both Ministry of Forests (MoF) and BC Timber Sales (BCTS) staff. The MoF's staff are involved with the administration and enforcement of government forest management policy. The BCTS' staff are involved with the planning of their operations.

9.4.4 Fort Nelson TSA employment and employment coefficient summary

The employment supported by the 2004 harvest in the Fort Nelson TSA and the corresponding employment coefficients are shown in Table 41. Coefficients have been calculated at the TSA and provincial level to highlight the importance of the forestry sector within the Fort Nelson TSA and to identify the contribution that the Fort Nelson TSA's forestry sector makes to the provincial economy. The two levels are defined as follows:

1) TSA employment comprises of residents of the Fort Nelson TSA whose employment is dependent on the forestry sector within the Fort Nelson TSA directly or indirectly and who rely on the Fort Nelson TSA timber supply; and,
2) Provincial employment comprises of all forestry sector employment in the province that relies on the Fort Nelson timber supply, including both residents of the Fort Nelson TSA and those who live elsewhere.

Employment is divided into direct, indirect and induced components; the sum of the components is the total impact. The coefficients are expressed as the number of full-time jobs, or person-years, per 1000 cubic metres of timber harvested. Indirect and induced employment figures were derived using employment multipliers developed by the Ministry of Management Services. Please refer to Appendix 1 for details on the methodology.

Table 41: Fort Nelson TSA average forest sector employment and employment coefficients, 2004

Activity	Fort Nelson TSA employment (persons-years)	Fort Nelson TSA coefficients (person-years/'000 cubic metres)	Provincial employment (person-years)	Provincial coefficients (person-years/'000 cubic metres)
Harvesting, Hauling and Administration	94	0.07	237	0.16
Silviculture	15	0.01	165	0.11
Timber Processing	631	0.44	648[1]	0.45
Total Direct	740	0.50	1,050	0.73
Indirect/Induced	298	0.20	1,233	0.86
Total	**1,038**	**0.72**	**2,283**	**1.58**

Note: The employment estimates are in person-years based on 2004 employment and the 2004 annual harvest of 1.441 million cubic metres.

[1] A survey was conducted to estimate the employment for the TSA but not for the province. In TSR 2, a survey for both the TSA and provincial employment was conducted. The TSR 2 timber processing provincial coefficient was 0.45 PY/1000 m^3, which was used to estimate the provincial employment (0.45 PY/1000 m^3 X 1,441,000 m^3 = 648 PY)

9.4.5 Fort Nelson TSA employment income

In 2001, the average annual income for forest sector employees in the Northern Rockies District was approximately $41,977. For indirect and induced employment the average annual income was approximately $32,117. The direct income associated with the forest sector in the Fort Nelson timber supply area averaged $42.8 million per year and indirect and induced income averaged $38.4 million per year. Combined, total income associated with the Fort Nelson TSA harvest averaged $81.2 million per year. Income levels, average wages and salaries, and total income per thousand cubic metres are shown in Table 42.

Table 42: Average direct and indirect/induced incomes and total employment income, 2001

	Average annual income/ worker[1]	Total annual income ($ million)	Total annual income per 1000 cubic metres[2]
Direct	41,977	42.8	32,650
Indirect/ Induced	32,117	38.4	29,290
Total:		**81.2**	**61,940**

1 Source: Stats. Canada. 2001 Census –Customized Data for the Northern Rockies District. Note that the figures in this table are lower than that reported in TSR 2 Socio-economic Analysis ($46,030 for direct and $34,075 for indirect/induced), and it may be in part of a small sample size (70 for direct and 45 for indirect/induced for the entire NRD)

2 The annual harvest in 2001was 1.311 million cubic metres.

9.4.6 Provincial government revenues

The provincial government receives various taxes and other revenues from the forest industry. The forest industry pays stumpage, royalties, and rents to the provincial government for the rights to harvest timber and its use. Furthermore, it pays other industry operating taxes such as logging, corporate income, property, and sales taxes. The provincial and federal governments also receive revenues from forestry employees through income taxes. The oil and gas industry also contributes to these stumpage payments through clearing of forested lands to support their operations.

In 2003, Canfor paid approximately $34.5 million to the municipal, regional and provincial government in stumpage, corporate tax, property tax, employers' Canada pension plan (CPP), employment insurance (EI), provincial sales tax (PST), and fees to worker's compensation board (Table 43). Fees paid to the government from timber purchased from BCTS and other cutting permits were not available. As a result, it was estimated that these fees collectively, were similar to fees paid per cubic metre logged by Canfor (e.g. $27,000/1000 m^3/year as shown in Table 43). Fees paid to the government for private timber, timber from BCTS or other cutting permits therefore were estimated to be approximately $3 million.

Table 43: Average provincial government revenues, 2003

	Annual revenue ($ millions)	**Annual revenue per 1000 m^3**
Canadian Forest Products	34.5	27,000
BC Timber Sales and Other Cutting Permits	3.0	27,000
Total:	**37.5**	**27,000**

1 The annual harvest in 2003was 1.392 million cubic metres.

10 Socio-economic Implications of the Base Case Harvest Forecast

The socio-economic analysis focuses on harvest level changes in the short- to medium-term (0 – 30 years) from present and considers the implications of these changes on economic measures such as forestry employment, income, and provincial revenues. Because such economic measures are closely influenced by the harvest level, the current AAC and the base case harvest forecast will be used as a surrogate for harvest and used to examine a possible future economic situation in the Fort Nelson TSA. It should be noted that the analysis is based on the current assumptions such as employment and income coefficients, labour productivity, mill production. It is assumed that these assumptions remain constant in the future. However, such assumptions can change due to changes in market conditions, timber processing technologies, etc. Nonetheless, the analysis provides an indication of the magnitude of impacts to the employment, income and revenues given a change in harvest levels.

10.1 Short- and long-term implications of alternative harvest levels

Based on the results of this timber supply analysis, the current AAC of 1,500,000 cubic metres can be maintained over the short and long-term. The base case forecast of 3,163,000 cubic metres represents an increase of 1,663,000 cubic metres over the current AAC. The current AAC could annually support:

- Estimated 1,080 person-years of total employment and $45.2 million of employment income in the Fort Nelson TSA,
- Estimated 2,385 person-years of total employment and $92.9 million of employment income in the province, and
- Estimated $40.5 million of total provincial revenue.

The base case harvest level could potentially support approximately 2,227 person-years of total employment and $95.5 million of employment income in the Fort Nelson TSA. Furthermore, it is estimated to support 5,029 person-years of total employment and $195.9 million in employment income in the province. The DFAM Group suggests the employment estimates associated with the base case harvest may be optimistic, as the logistics to sustain such a harvest flow may not be realistic. Whether or not the timber could be harvested and processed at all depends on numerous factors, such as timber accessibility, harvest and transportation costs, market demand and prices, and future expectations of resource uses in the forests. A summary of the employment and income that can be supported by both the current AAC and the base case harvest is shown in Table 44.

Table 44: Socio-economic impacts of implementing the Fort Nelson TSA base case forecast

	At current AAC[a]	Base case harvest forecast
Timber supply (cubic metres)	1,500,000	3,163,000
Harvest level (2000-2004 average)	1,355,000	N/A
Difference from current AAC	145,000	1,663,000
Fort Nelson Timber Supply Area		
Employment	**(person-years)**	
Direct	765	1,613
Indirect/induced	315	664
Total	1,080	2,227
Employment income	**($ million)**	
Direct	34.5	72.9
Indirect/induced	10.7	22.6
Total	45.2	95.5
Province[b]		
Employment	**(person-years)**	
Direct	1,095	2,309
Indirect/induced	1,290	2,720
Total	2,385	5,029
Employment Income	**($ million)**	
Direct	49.0	103.3
Indirect/induced	43.9	92.6
Total	92.9	195.9
Provincial government revenues	**($ million)**	
All taxes and fees paid to the government	40.5	85.4

(a) The estimates for current employment in this table differ from those in Table 41 and Table 42, as the figures above are based on the current AAC of 1.5 million cubic metres. Table 41 and Table 42 uses the 2004 volume of 1.441 million cubic metres, and 2001 volume of 1.311 million cubic metres, respectively.

(b) Provincial employment and income estimates include TSA employment and income.

10.2 Requirements of timber processing facilities

Approximately 95% of the timber processed at Fort Nelson mills is harvested within the Fort Nelson TSA. The remainder comes from private lands and woodlots that are within the Fort Nelson forest district. The base case forecast indicates that this supply of timber for the Fort Nelson mills is very secure. Both the deciduous and the coniferous timber supplies are sufficient, at least in volume, to supply the current needs of local processing facilities.

10.3 Regional timber supply implications

In many regions of the province, the wood processing industry does not rely solely on the local timber supply but on the larger region, often beyond TSA or district boundaries. In the Fort Nelson TSA, however, the timber supply from the TSA is the largest and most important source of timber to local mills. As a result, changes in other TSAs or regions do not have a significant effect on local timber processing. While currently uncertain, a potential increase in harvest level in the Fort Nelson TSA could provide greater self-sufficiency and security for local mills and potentially in other areas of the province as well. This assumes that the new timber supply can be harvested and milled economically. Canfor has noted that the current base case harvest level may contain timber in inaccessible areas and that would be uneconomical to transport to the mill.

10.4 Summary

The Fort Nelson TSA has a healthy economy with an expanding population and labour force, and a low unemployment rate. The Fort Nelson forest industry is an important driver of the local economy and in 2001, directly accounting for approximately 27% of the regions's labour force. Canadian Forest Products Ltd. (Canfor) and BC Timber Sales are the dominant tenure holders. Canfor also operate the only three major mills in the TSA: a sawmill, a veneer/plywood mill and an oriented strand board mill. In 2004, the forest industry in the TSA supported approximately 1,050 person-years of direct employment and a further 1,233 person-years of indirect and induced employment across the province Residents of the Fort Nelson TSA account for approximately 71% of the direct employment.

A base case harvest forecast of 3,163,000 cubic metres is currently predicted. At this harvest level, the associated direct employment would increase to approximately 2,309 person-years in the province and indirect and induced employment could increase to approximately 2,720 person-years. Provincial government revenues would also increase with stumpage and related payments, industry taxes and employee income taxes to approximately $85.4 million per year, assuming a continuation of current tax rates.

Considering the uncertainty identified in the sensitivity analyses around the base case harvest forecast as well as the operational feasibility and constraints of sustaining a much higher harvest level compared to the current AAC, the base case harvest forecast may be optimistic. The actual employment and community related impacts will depend on the actual AAC set by the provincial chief forester and the ability of the forest industry to economically harvest and process the timber.

11 References for Socio-economic Analysis

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Appendix 1: Socio-economic Analysis Background Information

Limitations of Economic Analysis[25]

The report identifies potential positive or negative employment and income impacts, changes in government revenues, and community impacts at harvest levels indicated by the base case harvest forecast. This type of analysis requires several assumptions of which the reader should be aware. Some of these assumptions are outlined below:

- **Employment multipliers** — the multipliers used in the analysis of indirect and induced impacts are based on analytical assumptions and estimated using data collected at a date, thus they reflect industry and employment conditions at that time. Consequently, they may not accurately reflect current/future industry conditions. While generally good indicators when based on fairly recent information, older multipliers can be dated and potentially unreflective of the industry under examination. In any impact analysis, the information should be considered as order of magnitude indicators.
- **Employment coefficients** — employment impacts associated with future harvest levels are calculated using employment coefficients (person-years per 1000 cubic metres). This approach assumes that the industry structure will be the same in future as it is today. While reasonably accurate in the short-term, the employment coefficients may change in future, as a result of changing market conditions or production technologies, for example.
- **Timing of impacts** — employment impacts are shown to occur simultaneously with a change in the harvest level. While fairly accurate for the harvesting sub-sector, this may not be the case for the processing and silviculture sub-sectors of the forest industry. Additionally, indirect and induced impacts will likely occur over a longer period of time, as business and consumer spending levels adjust.
- **Processing thresholds** — processing job impacts are unlikely to occur in direct proportion to harvest changes, i.e., a 10% harvest reduction (increase) may not lead to a 10% processing employment reduction (increase). Impacts are more likely to occur in a step-wise manner related to processing thresholds. A processing threshold is the level of a mill's timber supply where, when reached, will cause a mill to either lay-off a shift (add a shift) or shut down the mill, temporarily or permanently. Accurately predicting a mill's threshold level is not possible. As a result, the analysis may overestimate processing impacts if mills continue to operate the same number of shifts, but perhaps at lower production levels, or alternatively could underestimate impacts if a mill were to eliminate a shift. Over the medium- to long-term the impact figures should be reasonably accurate, however.
- **Government expenditures** — provincial government expenditures are more related to population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite harvest changes and any subsequent change in government revenues. However, public expenditures would likely

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[25] The source of this socio-economic background information is from the *TSR 2 Socio-economic Analysis for the Fort Nelson TSA* and has been edited here to reflect the assumptions in TSR 3.

change if community population levels change sufficiently. This would amplify the community impacts of forestry job losses or gains.

- **Proportional harvest reductions** — harvest reductions are assumed to be spread evenly among all licensees and all forms of tenure.

Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the Fort Nelson TSA. Other general economic data are from B.C. STATS, the Ministry of Management Services, Statistics Canada and the Northern Rockies Regional District.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1) harvesting;
2) silviculture; and,
3) timber processing.

The procedure for estimating employment and income impacts involves several steps. The first step was to assess current activity in each of the three sub-sectors. This was followed by an estimate of indirect and induced employment and employment income impacts, using data from BC Statistics. Next, employment coefficients were calculated and then applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using the Ministry of Forests stumpage estimates and data from the licensees and BCTS.

Employment — harvesting

Direct employment in harvesting consists of all woodlands related jobs including harvesting, log transport and hauling, log salvage, planning and administration functions. While road building and maintenance work are important activities in the forest industry, the employment multipliers used in this analysis define these activities as indirect rather than direct, as a result road building and maintenance employment are not included in the direct impact estimates; including these as direct would result in double-counting and an overestimation of employment impacts.

Data on employment, place of residence and timber flows were obtained through a survey of licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of resident versus non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

- TSA direct employment in harvesting — consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and,
- Provincial direct employment in harvesting — consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients on a per 1000 cubic metres basis. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilizing, pruning and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part-time during the year. Because of this, silviculture jobs were converted into equivalent full-time person-years of employment. Respondents were also asked to provide estimates of the percentage of their silviculture employees who resided within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production and sources of timber was gathered from TSA mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA.

Employment figures were also adjusted to reflect the residences of workers; i.e., those who lived within the TSA and those who lived outside the TSA. Employment in timber processing which is supported by chip by-products from milling operations was also estimated in a similar fashion.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employment in the forestry sector represent those individuals who work to provide goods and services to firms directly engaged in the basic forestry sector: for example, those who provide log transport services. Induced employment are those individuals who work to provide the goods and services purchased by employees who are directly and indirectly engaged in the industry; for example, those who work in retail outlets. Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the BC Statistics.

The average of two sets of employment multipliers were used for this report: migration multipliers and no-migration multipliers. The migration multipliers assume that a displaced worker will leave the region, reducing total income in the region by his/her full wage. The no-migration multipliers assume that a displaced worker remains in the area, and receives employment insurance benefits and that new jobs are filled by previously unemployed residents. The no-migration multipliers assumes that displaced workers leave the local area and that new jobs are filled by in-migrants; this diminishes the degree of induced impacts associated with a change in direct employment.

The TSA and provincial employment multipliers used in the Fort Nelson TSA analysis are shown in the table below.

	TSA No Migration	**TSA Migration**	**TSA Average**	**Provincial Average**[1]
Logging	1.25	1.38	1.32	1.1739
Wood Manufacturing	1.35	1.50	1.43	

[1] The provincial average is calculated based on TSR 2 Socio-economic analysis report (1996-1998). No new information is available since TSR 2.

Employment estimates of alternative timber supply levels

To estimate employment generated by alternative timber supplies, the forecasted harvest level is multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on "current" industry productivity, harvest practices and forest management assumptions and will not likely reflect industrial operating conditions far into the future. Therefore, the employment estimates should be viewed as an indication of the magnitude of change rather than as precise estimates of changes in employment levels.

Appendix 2: List of Acronyms

Acronym	**Definition**
AAC	Allowable Annual Cut
AU	Analysis Unit
BCTS	BC Timber Sales
BEC	Biogeoclimatic Ecosystem Classification
BEO	Biodiversity Emphasis Option
Canfor	Canadian Forest Products Ltd.
CFS	Canadian Forest Service
CFLB	Crown forested land base
DBH	Diameter at Breast Height
DFAM	Defined Forest Area Managment
DIB	Diameter Inside Bark
DWB	Decay, Waste, and breakage
ECA	Equivalent Clearcut Area
ESA	Environmentally Sensitive Area
FDP	Forest Development Plan
FESL	Forest Ecosystem Solutions Ltd.
FIZ	Forest Inventory Zone
FPC	Forest Practices Code
FRPA	Forest and Range Practices Act
FSOS	Forest Simulation Optimization System
GIS	Geographic Information Systems
GMZ/GRZ	General Resource Zone
ISIS	Integrated Silviculture Information System
ITG	Inventory Type Group
LRMP	Land Resources Management Plan
LU	Landscape Unit
LUPG	Landscape Unit Planning Guide
MAI	Mean Annual Increment
MHA	Minimum Harvestable Age
MOF	British Columbia Ministry of Forests
MSRM	British Columbia Ministry of Sustainable Resource Management
MSYT	Managed Stand Yield Table
NSR	Not Satisfactorily Restocked
NSYT	Natural Stand Yield Table
OAF	Operational Adjustment Factor
OGSI	Old Growth Site Index
RMZ	Riparian Management Zone
RRZ	Riparian Reserve Zone
RVQC	Recommended Visual Quality Class

Acronym	Definition
SEA	Socio-Economic Analysis
SI50	Site Index for age 50
SIBEC	Site index Biogeoclimatic Ecological Classification
THLB	Timber Harvesting Land Base
TIPSY	Table Interpolation Program for Stand Yields
TSA	Timber Supply Area
TSR	Timber Supply Review
UWR	Ungulate Winter Range
VAC	Visual Absorption Capacity
VDYP	Variable Density Yield Prediction
VEG	Visually Effective Green-up
VRI	Vegetation Resources Inventory
VQO	Visual Quality Objectives
WHA	Wildlife Habitat Area
WTP	Wildlife Tree Patch
WTR	Wildlife Tree Retention

Appendix 3: Glossary

The glossary has been compiled from various sources including the glossary from the *Fort Nelson Timber Supply Area Analysis Report* (March 2000), the *Landscape Unit Planning Guide* (MoF and MELP 1999), and *Modelling Visuals in TSR III Bulletin* (MoF, 2003)

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Base case forecast	The timber supply forecast, which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analyses.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, and includes the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Cutblock	A specific area, with defined boundaries, authorized for harvest.
Cutblock adjacency	The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Defined Forest Management Area (DFAM)	The DFAM initiative was envisioned to provide licensees and BC Timber Sales in TSAs with a framework for collaborative forest management and a greater responsibility to more effectively perform a set of strategic forest management activities to standards set by the province. A review of timber supply analysis at least once every 5 years, except for units that were postponed by the chief forest in accordance with legislation, is the collective responsibility of DFAM.
Early seral	Stands are defined as early seral if they are younger than: 40 years in the Spruce-Willow-Birch (SWB) biogeoclimatic zone; 40 years for coniferous stands and 20 years for deciduous stands in the Boreal White and Black Spruce (BWBS) biogeoclimatic zone.
Employment coefficient	The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Employment multiplier	An estimate of the total employment supported by each direct job; for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.
Environmentally sensitive areas	Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Forest cover objectives **Forest cover requirements**	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green–up).
Forest inventory	An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.
Forest Practices Code	Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.
Forest type	The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Growing stock	The volume estimate for all standing timber, at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Indirect and induced jobs	Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.
Integrated resource management	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

Land and Resource Management Plan (LRMP)	A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision-making, and resource sustainability.
Landscape-level biodiversity	The Forest Practices Code Biodiversity Guidebook provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.
Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest-planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mature seral	Stands are defined as mature seral if they are older than: 120 years in the Spruce-Willow-Birch (SWB) biogeoclimatic zone; 100 years for coniferous stands and 80 years for deciduous stands in the Boreal White and Black Spruce (BWBS) biogeoclimatic zone.
Minimum harvest age	The minimum stand age by which stands become operationally or economically viable to be harvested.
Natural disturbance type (NDT)	An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas with less stand-initiating disturbance have older forests, and generally a greater abundance of species.
Not satisfactorily restocked (NSR) areas	An area not covered by a sufficient number of well-spaced tree stems of desirable species. Stocking standards are set by the B.C. Ministry of Forests and Range. Areas harvested prior to 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since 1987 are classified as current NSR.
Old seral	Stands are defined as old seral if they are older than: 250 years in the Spruce-Willow-Birch (SWB) biogeoclimatic zone; 140 years for coniferous stands and 100 years for deciduous stands in the Boreal White and Black Spruce (BWBS) biogeoclimatic zone.
Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

Person-year(s)	One person working the equivalent of one full year, defined as at least 180 days of work. If someone works full-time for 90 days, he or she accounts for 0.5 person-years.
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Pruning	The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.
Pulpwood agreements	An agreement applying to a fixed geographic area that allows harvesting of timber below sawlog standards if mill residues suitable for the facility under the agreement are not available.
Regeneration delay	The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.
Rehabilitation	Removing all non-commercial cover, preparing the site and stocking it with acceptable, commercially valuable species.
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Sensitivity analysis	Process that examines how uncertainty in data and management assumptions affect timber supply.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand	A group of trees that are similar in tree species/ tree species mix, age, and site productivity
Stand level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Timber harvesting land base	Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.

Timber supply area (TSA)	An integrated resource management unit established in accordance with Section 7 of the Forest Act.
Timber supply	The amount of timber that is forecast to be available over a specified time period, under a particular management regime.
Uneconomic areas	Areas defined as unavailable for harvest for economic or terrain-related reasons. Characteristics used in defining uneconomic areas include distance from processing facilities, existing roads, difficulty of road access, and availability of suitable timber. Areas considered uneconomic can change over time as a function of changing harvesting technology and economics.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Visually Effective Green-up (VEG) height	The VEG height is the stage at which regeneration is perceived by the public as newly established forest. When VEG is achieved, the renewed forest cover generally blocks views of site disturbances such as stumps, slash, road cuts, exposed rock and soils.
Visual sensitivity	A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Appendix 4: Description of Data Input and Assumptions for Timber Supply Analysis (Data Package)

The following tables and descriptions in this Appendix outline the methods and inputs used to derive the timber harvesting land base and to construct the timber supply model for the Fort Nelson TSA. This information represents current forest management in the area. Current management is defined as the set of land use decisions and forest and stand management practices currently implemented and enforced.

Some changes to the data assumptions were made after the data package, *Fort Nelson Timber Supply Area Timber Supply Review 3 Data Package, July 9, 2004*, was approved by the MoF timber supply analyst responsible for this TSA. Changes include:

- Revisions to the definition of non-productive areas. In the approved data package, non-productive was defined using a combination of Projected Type ID and Non-Productive Descriptor in VRI. In the current timber supply analysis, non-productive is defined the same way, except it will not include those areas where the BC Land Cover Classification Scheme Level 1 is vegetated or where there is species information available.

  The difference between the data package and this analysis is that the THLB in this analysis is 12 hectares larger (1,432,269 ha vs. 1,432,257 ha); the crown forested land base (CFLB) is also 106, 932 ha larger (5,741,212 ha vs. 5,634,280 ha).

- Inclusion of the 1997 established VQOs along the Alaska Hwy corridor. An addition 116, 811 ha in the CFLB and 36,899 ha in the THLB of VQOs have been added to the land base.

12 Inventory and Data Description

12.1 Data Sources

Most of the data were provided from the Ministry of Forests (MoF), the Ministry of Sustainable Resources Management (MSRM), Canadian Forest Products Ltd. and BC Timber Sales. The list of inventory information is shown in Table 45. Some of the data sources are also discussed in more detail in the sections below.

Table 45: Inventory information for the Fort Nelson TSA

Data	Source*	Vintage	Update	Scale	Comments
Inventory					
Vegetation Resources Inventory	MSRM	2002/2003		1:20,000	Total of 836 (1:20 000) mapsheets. Of which, 249 are Phase II VRI and 587 are "rolled over" VRI.
Ecological					
Biogeoclimatic classification (version 5.0)	MOF	1995	2003	1: 20,000	
Natural Disturbance Units	MSRM	2001	2002	1:20, 000 to 1:250,000	
Karst potential map	MOF	1999		1:250,000	
Budworm incidence mapping	CFS – Pacific Forest Region	1998/2002		1:50,000	
PEM/TEM coverage	Various sources – see description			1:50,000	
Administrative					
Ownership	MOF	2000	2002	1:20,000	From FC1. Woodlots codes are not included.
BC Parks	WLAP	1999	2001	1:20,000	
Woodlots	MOF – Fort Nelson Forest District	2003		1:20,000	
Operating Areas	MOF – Fort Nelson Forest District			1:20,000	
Landscape Units	MSRM	1998	2003	1:250,000	
Region and district boundary	MOF – Fort Nelson Forest District	2000	2003	1:20,000	
Agricultural Land Reserve	LRC		2003	1:20,000	
Forest region and compartment	MOF – Fort Nelson Forest District	2000	2002	1:20,000	
Operational					
Forest Development Plan	Canfor/ BCTS	2002-2007		1:20,000	Includes wildlife tree patches and other reserves - all reserves have been coded as WTP; also includes roads
Depletions	MSRM	2002		1:20,000	
Terrain Stability	Canfor (Kokanee Forest Consulting, Klohn-Crippen, JM Ryder & Associates)	2000		1:20,000	
ESA	MSRM	2001	2002	1:20,000	
Range Burns	MOF – Fort Nelson Forest District	1999		1:20,000	
Water					
Domestic water licences	MSRM - Water licensing office	1997	2003	1:20,000	Point of Diversion
Wildlife					
Caribou Wildlife Winter Range	WLAP		2000		
Protected Area Strategy (PAS)	MOF	2001			
Recreation					
Visual landscape inventory (VLI)	MSRM	1997	2002	1:250,000 1: 50,000	The inventory is 1:250,000 except for the inventory around the Alaska Hwy and Klua Lakes, which were done to an accuracy of 1:50,000.
Recreation feature inventory (RFI)	MSRM	1991			
Recreation opportunity spectrum (ROS)	MSRM	1996		1:20,000?	
Planning					
LRMP – RMZ, ERDZ, SMZ	MSRM	1997	2002	1:250,000	
Natural Disturbance					
Spruce budworm infestation	CFS	1990	2002	1:20,000	
Roads and Seismic					
TRIM I and II	MSRM	1987, 1996		1:20,000	Used for roads, seismic lines, pipelines, streams
Compiled road coverage	FESL			1:20,000	Variety of sources
Seismic and oil and gas roads	OGC	2000 -2003		1:20,000	

*MOF= Ministry of Forests, MELP= Ministry of Environment, Land, and Parks, WLAP= Ministry of Water, Land and Air Protection, LRC = Land Reserve Commission, LUCO= Land Use Coordination Office, OGC=Oil and Gas Commission, FESL=Forest Ecosystem Solutions Ltd. CFS = Canadian Forest Service

12.1.1 Vegetation Resource Inventory

During 2002/2003, Fort Nelson Division of Canfor received funding from the Forest Investment Account to group sampling approximately one third of the TSA according to Vegetation Resource Inventory (VRI) standards: the other two thirds contained old forest cover data that have been "rolled-over" into the new VRI format (mdb). It should be noted that the "roll over" process does not generate a true VRI database. It maintains the old FC1/FIP inventory information in a new database format. The new VRI attributes will remain as blank fields in the "rolled over" VRI database as no information is gathered or available from the traditional inventory databases.

The completion of the VRI involved staff from BCTS and the Regional and District staff of MOF and MSRM. VRI Phase I photo-interpreted inventory has projected stand attributes to 2003 whereas VRI "rolled over" was projected to 2002. The "rolled over" VRI comprises a total of 6,863,581 ha of the TSA whereas 3,004,473 ha are in VRI Phase I. Adjustment factors derived from VRI Phase II ground sample data for age, height and net volume have been applied to the VRI Phase I area and are documented in Jahraus and Associates (2003).

In TSR 2, the chief forester noted that the existing older forest inventory was a primary concern due to issues with broad polygon typing, incorrect species labelling, incorrect site productivity (site index) estimates, and under-representation of the understory component. The Phase I photo-interpreted VRI has addressed some of the issues and in particular, provided an improved distinction between white and black spruce leading stands. In addition, the VRI Phase II ground sample data has provided a measure of confidence of the VRI Phase I photo-interpreted data with a known level of confidence.

12.1.2 PEM/TEM Mapping

Four TEM projects were completed in 1998 within the Fort Nelson TSA including the Smith/Vents River TEM, Labiche/Sandy TEM, Snake/Sahtaneh TEM and the Dunedin TEM. MSRM has also completed a PEM for the Muskwa-Kechika. No independent accuracy assessments have been completed for these projects.[26]

Canfor have recently completed the accuracy assessments for the Patry PEM project and the Sahtaneh TEM project. However, they are not included in the analysis because they were not completed at the time of the analysis.

12.1.3 Karst Potential Inventory

The provincial karst potential inventory indicates areas of potential karst and areas of known karst. There are 8,289 ha of known karst areas. The known karst is located in the northwestern region of the TSA. A continuous north-south band of known karst exists in the Grayling, Scatter, and Redpott Landscape Units (5,331 ha, 59ha, and 2,206 ha, respectively). In addition, there are 676 ha of known karst in the Liard Hot Springs landscape unit. The DFAM group do not feel that there will be a major timber supply impact in these karst areas as there are no local guidelines for their operational management at this time. As such, these areas are noted but not taken out of the THLB at this time.

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[26] Email communication with Corey Erwin (March 9, 2004).

12.1.4 Ownership Inventory

There are two woodlots in the TSA; one is an active woodlot (W1817) comprising 588 ha and the other woodlot (W171), comprising 561 ha, is currently inactive. W1817 was not included in the original ownership file but has been added based on a spatial woodlot coverage provided by the Fort Nelson Forest District. W171 will be assigned to a miscellaneous reserve status, which may be harvested in the future.

12.1.5 BC Parks and Protected Area Boundaries

The Ministry of Water, Land and Air Protection provided the boundaries for BC parks, protected areas and ecological reserves. This data is updated to 2001 and confirmed to be accurate on a 1:20, 000 scale[27]. The existing ownership coverage for parks (63N and 67N) and ecological reserves (60N) was outdated, as many parks and protected areas have been legally established since TSR2. The Land Resource Management Plan map was also outdated as the areas with "proposed protected" resource management type are now "existing established" RMZs.

12.1.6 Road data

A spatial road coverage has been compiled from road features from TRIM I and II, existing and proposed roads from forest development plans provided by Canfor and BCTS, an in-house road coverage from Canfor, and petroleum development roads from the Oil and Gas Commission.

The compiled road network illustrates that many of the logging roads identified in the above sources were only accessible from seismic lines. It was confirmed by the DFAM group that many seismic lines are actively used for timber access. It is, however, impossible to determine which seismic lines are being used for transportation, therefore, no seismic lines have been reclassified as roads. Seismic features will be included in determining future access requirements.

12.1.7 TRIM data

Streams, roads, transmission lines, seismic lines and pipelines were extracted from TRIM I and II. A buffer width was applied to each feature to determine an appropriate area reduction for the land base netdown, which will be discussed in Section 13.3.4 and 13.4.5.

12.1.8 Visual landscape inventory

Detailed (1:50,000) visual landscape inventories were completed for the Klua Lakes view shed in 1992, and for a portion of the Alaska Highway corridor from Beaver Creek to Summit Lake in 1995. In 1995, a broad mapping of all the visually sensitive areas in the district was completed at a scale of 1:250,000 and the district manager has declared these areas as 'scenic areas' for consideration in all forestry planning activities.

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[27] Phone correspondence with Steven Webb, Boundary Coordinator, Land & Permit Administration Section, WLAP, April 22, 2004.

13 Land base

This section describes how the timber harvesting land base (THLB), or the area that is available for harvest, is determined. The total land base initially contains a variety of land types including areas that are not Crown controlled. The TSA is defined as the total land base excluding private land, federal land, woodlots, and First Nations reserves. Once the TSA area is defined, areas not containing trees and are considered non-productive are removed (e.g. bare ground/rock and water bodies) to identify the productive Crown forested land base (CFLB). Finally, those areas that are forested and contribute to non-timber values, but are not eligible for harvest are removed, resulting in the THLB.

13.1 Timber harvesting land base definition

The THLB is determined by a netdown process, in which areas ineligible for harvest are sequentially removed from the total land base. Once an area has been removed, it cannot be deducted again further along in the netdown process to eliminate the potential for double counting. For this reason, the gross area of netdown factors is usually greater than the net area removed (a result of overlapping resource issues).

Table 46 summarizes the netdown procedure where areas are removed in the order presented to define the total land base, TSA land base, Crown forested land base, current and future timber harvesting land base.

Table 46: Timber harvesting land base determination for the Fort Nelson TSA

Classification	Total Area (ha)	Net Area Removed (ha)	Percent of Total TSA area (%)	Percent of CFLB (%)	Report Section
Total TSA area	**9,868,067**	**9,868,067**			
Land not managed by MoF or is not part of the TSA (e.g.. private, woodlots, federal, Indian, military reserves)	29,927	29,927			13.2
Area Management by the MOF		**9,838,140**	**100.00**		
Reductions to TSA:					
Non-forest, non-productive, no typing	3,712,709	3,705,856	37.62		13.3.1
Alpine (not previously accounted for)	3,006	3,006	0.03		13.3.2
Non-commercial cover (brush)	350,671	350,671	3.55		13.3.3
Existing roads, trails and landings	46,686	37,395	0.38		13.3.4
Total productive Crown forest land base (CFLB)		**5,741,212**	**58.18**	**100**	
Parks, UREPs and Ecological Reserves	1,059,861	371,322	3.76	6.47	13.4.1
NSR from wildfire, non-productive or misclassified	86,106	76,632	0.78	1.33	13.4.2
Non merchantable	301,193	250,253	2.54	4.36	13.4.3
Low timber productivity	4,344,268	2,729,564	27.66	47.54	13.4.4
Riparian reserve (stream, wetland and lake)	543,340	190,667	1.93	3.32	13.4.5
Environmentally sensitive areas	708,018	122,878	1.25	2.14	13.4.6
Unstable terrain	19,112	9,197	0.09	0.16	13.4.7
Wildlife range burn areas	354,999	27,109	0.27	0.47	13.4.8
Stand-level biodiversity (existing wildlife tree patches)	434	367	0.004	0.01	13.4.9
Seismic areas	111,957	26,026	0.26	0.45	13.4.10
Inoperable areas	7,419,049	361,670	3.67	6.30	13.4.11
Black spruce leading stands	1,215,896	143,258	1.45	2.50	13.4.12
Total Reductions to the CFLB:		**4,308,943**	**43.67**	**75.05**	
Current Timber Harvesting Land Base		**1,432,269**	**14.51**	**24.95**	
Future Reductions:					
Future roads, trails and landing		29,825	0.30	0.52	13.4.14
Future stand-level biodiversity (WTP)		6,272	0.06	0.11	13.4.15
Future Timber Harvesting Land Base		**1,396,172**	**14.15**	**24.32**	

13.2 Exclusions from the TSA Land Base

The land base netdown will identify the numerous reductions applied to the total area within the Fort Nelson Forest District to identify the TSA land base, the productive Crown forest land base, and the timber harvesting land base. This section will describe those areas that are removed from the Fort Nelson Forest District to identify the TSA land base.

13.2.1 Administrative classes that do not contribute to TSA forest management objectives

Areas managed by the BC MoF and Parks are considered to contribute to landscape biodiversity and are therefore included in the Crown productive forest, whereas areas in the forest management unit area and miscellaneous reserves are available for timber harvesting (Table 47). Areas in private ownership, woodlots, and Indian, federal, and military reserves are not included in the TSA land base, as shown in Table 48.

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Table 47: Land that contributes to the TSA forest management or biodiversity objectives (i.e. Crown forest land base) due to ownership

Ownership Code and Description	Total Area (ha)	% Contribution to CFLB	% Contribution to THLB
62-C Forest Management Unit	8,762,730	100	100
Parks, protected area and ecological reserves*	1,052,430	100	0
61-C Use, Public recreation, and enjoyment (UREP) reserves (>100 ha)	3,090	100	0
61-N UREP (≤100)	4,341	100	0
69-C Miscellaneous reserves (>100 ha)**	15,352	100	100
69-N Miscellaneous reserves (≤100)**	197	100	100
Total	**9,838,140**		

*Parks, protected areas and ecological reserves were derived from the BC Parks coverage. It did not contain ownership code; however, it would have encompassed 60N, 63N and 67N.

**Miscellaneous reserves include: forest service recreation reserve/corridor, watershed reserve, industrial reserve, islands reserve, map reserve, fish and wildlife management reserves and/or interpretive forests. Also included in category 69-C are 564 ha of what used to be woodlot W171.

Table 48: Land that does not contribute to the TSA forest management or biodiversity objectives due to ownership

Ownership Code and Description	Total Area (ha)	% Contribution to CFLB	% Contribution to THLB
40-N Private	16,102	0	0
50-N Federal Reserve	545	0	0
52-N Indian Reserve	8,126	0	0
53-N Military Reserve	4,552	0	0
77-N Woodlots	588	0	0
99-N Miscellaneous leases*	14	0	0
Total	**29,927**		

* Miscellaneous leases include: fairgrounds, rod and gun club sites, recreational cottage site leases and/or community organization leases.

13.3 Exclusions from the Crown Forest Land Base

This section describes the reductions, which are applied to the TSA land base to define the Crown forest land base, and are summarized in Table 46.

13.3.1 Non-forest and non-productive forest

VRI inventory attributes differ from the original FC1/FIP attributes in a number of important ways. While the FC1/FIP data standards provided a single attribute as far as the overall polygon classification is concerned, a polygon inventoried under VRI guidelines might contain several 'land classification' components (BCLCS). For example, a polygon might be classified as a Lake following FC1/FIP guidelines; however, the same polygon might be classified as 80% Lake and 20% productive forest land under VRI guidelines.

Based on comparisons between area and land classification, it was decided that polygons with multiple 'land classification' components should be reclassified following a 50% rule. For example: if more than 50% of a polygon is classified as water or non-vegetated (*e.g.* rock or exposed soils), then the polygon would be reclassified as a water body or non-productive, respectively.

Where only rolled-over VRI information is available, the non-forest and non-productive forest category is classified according to the projected type identity label (PRJ_TYPID) 6. For all areas classified as non-productive (either by PRJ_TYPID 6 in rolled-over VRI, or through the 50% rule in the true VRI), if there are species information or BCLCS_LEVEL1 is vegetated, then these areas are not considered non-productive.

Except for parks, ecological reserves, UREP and riparian areas, all areas that are classified as non-productive (or any of the land classification that will be removed from the Crown forest land base, as described in the following sections) but have been previously logged will remain in the Crown forest land base as well as the timber harvesting land base. The reductions for non-forest and non-productive areas within the Fort Nelson TSA are shown in Table 49.

Table 49: Areas in non-forest and non-productive forest

Description (NPD2)	TSA Area (ha)	% Reduction	Net Area Removed
Lake	85,027	100	84,925
River	80,542	100	80,509
Wetland	1,633,601	100	1,632,771
Non-Productive (NP)	1,908,978	100	1,903,091
No typing available (NTA)	4,561	100	4,560
Total:	**3,712,709**	**100**	**3,705,856**

13.3.2 Alpine

All area classified as alpine tundra and sub alpine parkland (AT) under the Biogeoclimatic classification (BEC) is considered non-harvestable and excluded from the Crown forest and timber harvesting land base. Where trees do occur in these areas their growth is usually stunted and they are very widely spaced. Individual trees rarely meet the minimum harvestable dimensions and, therefore, have no merchantable value. In the Fort Nelson TSA, there are 1,353,578 ha of alpine tundra of which, 3,006 ha have not been excluded under the unproductive/nonforest category (Section 13.3.1) as shown in Table 50.

Table 50: Reduction for alpine and sub alpine tundra

Description	Total Area (ha)	% Reduction	Net Area Removed (ha)
Alpine and sub alpine tundra not previously accounted for	3,006	100	3,006

13.3.3 Non-commercial cover

Non-commercial cover represents sites within the Fort Nelson TSA that are considered inappropriate for timber harvesting as they currently contain non-commercial tree and shrub species. Only through rehabilitation would these sites be considered for timber management.

Areas for which rehabilitation of non-commercial brush (NCBR) sites has occurred in the Fort Nelson TSA remain in the THLB. Historical non-commercial brush rehabilitation of willow brush sites, which have been planted to spruce, has been updated in the resultant data set and the inventory where appropriate. It is understood that relatively little non-commercial brush is being rehabilitated within the Fort Nelson TSA due to limited funding for this activity. Therefore, at this point no further rehabilitation is planned.

The non-commercial brush areas with VRI Phase II inventory will be removed in the non-productive forest category in Section 13.3.1. The area of the TSA for which the "rolled-over" VRI is available is excluded from the Crown forest and timber harvesting land base based on the

Non-forest Descriptor (NFD = NCBR) (Table 51). The non-commercial brush areas are not included in the Crown forested land base because no species, crown closure, stand age or volume data were available to determine if these areas are forested or not.

Table 51: Non-commercial brush

Description	Total Area (ha)	% Reduction	Net Area Removed (ha)
Non-commercial brush	350,671	100	350,671

13.3.4 Existing roads, trails and landings

Road data was acquired from TRIM I and II, Canfor's corporate road coverage, and forest development plan road coverage (from BCTS and Canfor). Two road coverages were also provided by OGC (including activity - fall of 2003). The second coverage provided about 384 km of additional roads classified as new petroleum development roads (PDR).

Roads are presented as linear features on maps: to determine an area, each road feature is buffered using Geographic Information Systems (GIS). The buffer represents half the road width and is applied to each side of the linear feature to equal the total width. Once the roads are buffered the associated area can be incorporated into the analysis dataset. A percent reduction for roads is calculated for each polygon that contains actual road segments. The reductions for each road class and its associated road length and buffer applied are shown in Table 52.

Table 52: Reductions for existing roads

Road Feature	Length (km)	Road width (m)	Buffer used in GIS (m)	Total Area (ha)*	Net Area Excluded (ha)
BC Rail	111	20	10	223	172
Highway	824	30	15	2,473	1,362
Paved	1,820	30	15	5,420	2,998
Road	4,898	20	10	9,778	9,199
Mainline	2,069	20	10	4,079	3,483
Petroleum Development Road (PDR)	384	20	10	746	289
Gravel	1,094	20	10	2,039	1,242
Rough Road	12,965	15	7.5	19,406	16,267
Overgrown Road	258	15	7.5	390	384
Total	**24,423**			**44,554**	**35,396**

* Road area listed above is the area resulting from the road buffer exercise and takes into account overlapping roads in which reductions are made in the same order the road features is presented in the table (*i.e.* where a highway crosses a paved road, the overlap is removed under 'net area excluded' for highway).

None of the road data provided contained landing features. However, it can be assumed that some road-related disturbances (landings and gravel pits) are captured in the vegetation resource inventory[28]. Where this is the case, they will have been removed as non-productive areas. Table 52 represents the area in main access roads; however, further road reductions are required for within block roads, trails and landings (RTL). The average percent area of permanent RTL in a cutblock is 2%, as determined by the amount of NP UNN (non-productive, unnatural) in ISIS (all data that was available between 1962 and 2003). Any area with a history of logging will receive an additional 2% reduction as shown in Table 53.

Table 53: Reductions for within block roads and trails

Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Existing roads (Table 52)	100	44,554	35,396
In block roads – non-mapped roads (additional 2% to all polygons with a history of logging)	100	2,132	1,999
Total	**100**	**46,686**	**37,395**

13.4 Exclusions from the Timber Harvesting Land Base

This section describes the exclusions to the crown forested land base to determine the timber harvesting land base.

13.4.1 Parks, UREPs and Ecological Reserves

Area in parks, use, public recreation, and enjoyment (UREP) and ecological reserves will not contribute to timber harvest but are assumed to contribute to biodiversity (Table 54). The protected areas that were outlined in the *Fort Nelson Land and Resource Management Plan* (LRMP 1997) and additional protected areas and ecological reserves have now been formally established (Order in Council) and are excluded from the THLB.

Table 54: Park, UREPs and Ecological reserve reductions

Description	Total Area (ha)	% Removed	Net Area Removed (ha)
Use, Public recreation, and enjoyment (UREP) reserves	7,431	100	5,106
Parks, protected area and ecological reserves	1,052,430	100	366,216
Total	**1,059,861**		**371,322**

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[28] Sixty hectares of gravel pits in the Fort Nelson TSA have been identified by the VRI and 1,846 ha have been identified as road or urban areas in VRI but it is unknown how much, if any, of the latter is in landings.

13.4.2 NSR from wildfire, non-productive or misclassified

Some land classified within the inventory as not satisfactorily restocked (NSR) has resulted from wildfire, is non-productive or is misclassified. These non-harvesting derived NSR areas (Table 55) are identified in the inventory based on a projected type identity label of 4, with no history of harvesting or silviculture activity. The regeneration of these areas remains uncertain and there are no commitments by the DFAM group for their regeneration, and as such they are excluded from the timber harvesting land base. The DFAM Group and Fort Nelson Forest District have confirmed that they do not replant following natural fires. More information on NSR can be found in Section 16.4.

Table 55: NSR from wildfire, non-productive or misclassified

Description	Total Area (ha)	Net Area Excluded (ha)	% Reduction
NSR from wildfire, non-productive or misclassified	86,106	76,632	100

13.4.3 Non-merchantable forest types

Non-merchantable forest types are stands that may be physically operable, but are currently not utilized due to being economically marginal or unfeasible for development and as such are removed from the THLB. These forest types include birch leading and larch leading stands (Table 56). A sensitivity analysis will be performed to include birch stands for harvest because there remains interest in their potential utilization. Currently, the DFAM group is not targeting birch leading stands for harvest in the TSA but they do utilize the minor component of birch when harvested in mixed species stands.

The DFAM group has identified that douglas-fir, hemlock and cedar do not grow naturally within the Fort Nelson TSA, and their occurrence in the inventory remains an error in species codes. It is unknown if these areas are forested or what species actually grow on these sites – they are therefore excluded from the THLB.

Table 56: Non-merchantable forest types

Leading Species	Inventory Type Group	% Reduction	Total Area (ha)	Net Area Excluded (ha)
N/A	0	100	25	20
Cedar	9	100	186	186
Douglas-fir	10	100	15	15
Hemlock-Spruce	16	100	16	15
Larch	34	100	39,927	22,338
Birch leading	40	100	261,016	227,679
Total			**301,187**	**250,253**

13.4.4 Sites with low growing potential

Throughout the Fort Nelson TSA there are stands that contain commercial tree species but have not, or are not, expected to achieve a productive condition within a reasonable growing period and are therefore excluded from the THLB. Existing mature stands (age being equal to or older than the 'reference age for maturity'), must achieve the minimum volume per hectare and height to be included in the THLB (Table 57).

Table 57: Criteria to identify mature stands with low growing potential

Species	ITG	Reference Age for Maturity	Minimum Height	Minimum Vol/ha	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Spruce	21-26	121	20	140	100	1,191,303	532,619
Pine	27-31	81	16	140	100	103,388	88,467
Aspen	41-42	81	20	140	100	130,992	121,443
Cottonwood	35-36	81	20	140	100	3,546	2,986
Balsam	18-20	121	n/a	140	100	60,586	53,300
Birch*	40	51	16	140	100		
Total						**1,489,815**	**798,815**

* Birch was excluded already due to non-merchantable category. It is provided here for sensitivity analysis.

Immature stands that have not yet reached maturity must meet a minimum reference SI (Table 58). The minimum reference SI was determined based on current performance in the TSA as well as consideration of the minimum site productivity that is required to achieve the minimum height and volume criteria within the reference age for each species, as listed in Table 58.

Table 58: Criteria to identify immature stands with low growing potential

Species	ITG	Reference Age for Maturity	Minimum Height	Minimum Vol/ha	Minimum SI	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Spruce	21-26	121	20	140	10.8	100	1,380,920	971,750
Pine	27-31	81	20	140	16.4	100	1,025,889	560,666
Aspen	41-42	81	20	140	15.9	100	393,107	347,017
Cottonwood	35-36	81	20	140	14.0	100	2,151	1,130
Balsam	18-20	121	n/a	140	12.0	100	52,386	50,186
Birch*	40	51	16	40	16.8	100		
Total							**2,854,453**	**1,930,749**

13.4.5 Riparian reserve and management zones

13.4.5.1 Streams

No complete stream classification exists for the Fort Nelson TSA. As a result, a methodology was required to approximate stream riparian reductions, which could be used in the land base netdown. Some rivers (S1 and S2 streams) are identified as polygons in VRI and as such their widths are available and can be buffered according to the *Riparian Management Area Guidebook* (Table 60 in Section 13.4.5.2). The remaining streams were translated from single line features in TRIM I[29].

With no complete field-based stream classification data for the remaining streams, a methodology was developed that combined the results of the Lower Dunedin Landscape Unit Riparian Analysis (Poulin and Associates, 2001) and information provided by MSRM, Aquatic Information Branch in Prince George. The results from Poulin and Associates and MSRM show a statistical relationship between stream order and stream class (e.g. a high correlation between stream order 1 and 2 with stream class 5 and 6 as well as steam order 3+ with stream class 1 to 4). An analysis was also completed for TSR 3 for the Lower Dunedin where the sample points of known stream classification from the Poulin and Associates study were compared to the stream order classified using GIS processing. Again the results showed a high correlation between the stream order and stream class.

A GIS program was developed to assign all TRIM streams in the TSA the appropriate stream order. Assumptions were made on the percentage of streams in each stream class as well as the riparian buffer widths required for each class. The details of the methodology, the limitations of the approach, and comments provided by MSRM are documented in Appendix 5.

The resulting stream classes and their 'effective' widths are illustrated in Table 59. The 'effective width' is the combined riparian reserve zone and riparian management zone weighted by stream class[30]. Although this approach may be satisfactory for use in TSR, the relationships should not be used for operational stream classification.

Table 59: Riparian reserve and management zone widths for streams

Riparian feature	Stream class	Stream Length (km)	Effective width (m)	Total Area (ha)	Net Area Removed (ha)
Streams	S1-S4*	73,841	33.50	184,553	86,801
	S5-S6**	194,105	2.31		

* corresponds to streams of order 3 +
** corresponds to streams of order 1 or 2

13.4.5.2 Lakes and wetlands

Both lakes and wetlands occur throughout the Fort Nelson TSA. Lake and wetland locations are identified explicitly in the "rolled over" VRI inventories while in the VRI Phase II they are identified based on a 50% rule as described earlier in this document (Section 13.4.5.2). Lake and wetland classes are categorized following the *Riparian Management Area Guidebook*. The appropriate buffer is applied to each wetland and lake class (Table 60) in order to calculate the appropriate reduction to the timber harvesting land base.

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[29] Note that the streams from TRIM I and TRIM II are identical.

[30] Please see Appendix 3 for the method of determining the effective width.

As mentioned in the previous section, some large rivers are identified as polygons (or double line streams in TRIM II), as such their widths are known for stream classification and are given the appropriate Guidebook reductions (Table 60). Therefore, reductions for streams are completed in two steps, one based on polygon-features (Table 60) and another based on the stream order methodology (Table 59).

Table 60: Riparian reserve and management zone widths for lakes and wetlands

Riparian feature	Wetland and Lake class	Class Definition	Reserve zone width (meters) 100% reduction	Management zone width (m)	Management zone retention (%)	Combined RZ and RMZ buffer width (m)*	RMA Gross area (ha)	Net Area Removed (ha)
Wetlands	W1	5 - 1000 ha	10	40	25	20	358,787	103,866
	W1 large	> 1000 ha	0	0	0	0		
	W3	1 - 5 ha	0	30	25	7.5		
	W5	wetland complex	10	40	25	20		
Lakes	L1	5 - 1000 ha	10	0	0	10		
	L1 large	> 1000 ha	0	0	0	0		
	L3	1 - 5 ha	0	30	25	7.5		
Streams	S1	20 - 100m wide	50	20	50	60		
	S1 large	>100m wide	0	100	50	50		
	S2	5 - 20m wide	30	20	50	40		

*the combined buffer width = reserve zone width + (management zone width x % management zone volume reduction)

13.4.6 Environmentally sensitive areas

Some forested areas are considered environmentally sensitive and/or significantly valuable for other resources. Many of these areas are identified and delineated during a forest inventory and are designated environmentally sensitive areas (ESAs). The ESA system uses the following categories: soil (Es), forest regeneration problems (Ep), recreation (Er), and wildlife (Ew). Two ESA categories are recognized: high and moderately sensitive, yet some of the ESA categories may overlap.

A complete table of ESA categories is presented in Table 61. In the context of timber supply analysis, ESAs result in a reduction in the harvesting opportunity on these sites. As in the TSR 2, all ESA areas identified as sensitive and/or significantly sensitive have been 100% excluded from the THLB.

Table 61: Environmentally sensitive areas

Feature*	Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Ep1	High regeneration problems	100	408,953	43,789
Ep2	Moderate regeneration problems	100	807	43
Er1	High recreation sensitivity	100	105	7
Er2	Moderate recreation sensitivity	100	1,459	313
Es1	High soil sensitivity	100	263,257	38,992
Es2	Moderate soil sensitivity	100	1,896	1,467
Ew1**	High wildlife sensitivity	100	3,744	833
Ew2c	Significant caribou habitat	100	27,797	20,158
Ew2g***	Significant goat habitat	100	0	17,276
Total			**708,018**	**122,878**

*A polygon can contain more than one ESA category. In cases where such overlap exists, the polygon area is assigned to ESA category of primary significance (e.g. ESA SP will be assigned to Es1).

** Includes 1,145ha of significant caribou habitat

*** There is a total of 183ha of significant goat habitat. However, goat habitat completely overlaps with the caribou habitat listed as Ew2c, and is reported there.

13.4.7 Terrain Reconnaissance Mapping

Several terrain reconnaissance mapping (Level D[31]) study areas have been completed throughout the Fort Nelson TSA, mostly in areas where there is significant terrain related concerns. The DFAM group currently does not operate in any area above terrain class III. Since the terrain reconnaissance mapping does not provide terrain class, an assumption was made that the reconnaissance class P (potentially unstable) and U (unstable) were equivalent to terrain class IV and V and Es2 and Es1 respectively, based on Appendix 1 in *Mapping and Assessing Terrain Stability Guidebook*. Areas identified as reconnaissance class P or U will be 100% removed from the THLB (Table 62).

Table 62: Terrain reconnaissance reductions based on Level D mapping

Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Terrain Reconnaissance Class P	100	12,612	6,820
Terrain Reconnaissance Class U	100	6,500	2,377
Total	**100**	**19,112**	**9,197**

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[31] Level D refers to the Terrain Survey Intensity Level, where the scale ranges from A (most checked) to E (least checked). The level is a measure of the reliability of mapping, where 1 to 20% of the polygons are ground-checked (*Mapping and Assessing Terrain Stability Guidebook*, 1999)

13.4.8 Wildlife range burns

Range burns are a technique used by the Ministry of Water, Land and Air Protection (MWLAP) to create wildlife habitat (grassland forest complexes) which provide grazing opportunities for large ungulates. Most range burn areas are located in the western portion of the TSA. MWLAP have provided the GIS data for the range burn areas and these areas have been fully removed from the THLB, as they are not expected to contribute to timber production now or in the future. The associated reductions are shown in Table 63.

Table 63: Wildlife range burns

Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Range Burn Areas	100	354,999	27,109

13.4.9 Stand-level biodiversity – wildlife tree retention

The management of stand level biodiversity is addressed through wildlife tree retention. In order to achieve landscape unit objectives, the establishment of wildlife trees by BEC variant is required. The *Landscape Unit Planning Guide* (March 17, 1999) provides direction for the management of wildlife trees, along with the approved changes to the *Landscape Unit Planning Guide* by the MOF and MELP (May 15, 2000), and the *Provincial Wildlife Tree Policy and Management Recommendations* (February 2000).

The existing spatial WTPs do not represent the full requirements across the entire TSA; therefore, further WTPs are required which are modelled as future WTPs. The additional area of WTPs required is calculated as the WTP target minus the existing WTP contribution (Refer to Section 13.4.15for more details). Spatial WTPs from Canfor and BCTS forest development plans (FDPs) have been identified and are also removed from the timber harvesting land base (Table 64).

Table 64: Reductions for wildlife tree patch/retention

Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Existing spatial WTP (from FDPs)	100	434	367

13.4.10 Oil and Gas and Transmission Lines

There is an extensive oil and gas exploration and development program throughout the Fort Nelson TSA, though most activity is concentrated on the lowland areas. Both activities result in a depletion of forest cover, mainly as a result of the establishment of seismic lines for exploration.

Quantifying the extent and location of oil and gas activities within the Fort Nelson TSA is a challenging undertaking given the amount of recent activity and the various types of seismic activity employed. Also, no one complete dataset currently exists which could provide a comprehensive oil and gas estimation for the TSA. Therefore, a variety of approaches were employed to estimate the measure of oil and gas activities.

Spatial seismic and pipeline data were extracted from TRIM II and buffered at 7m and 15m, respectively[32]. It is understood that TRIM II data is current to 1995. A spatial seismic coverage for 2001-2003 disturbances was received from OGC and these seismic features were buffered at 5m. The average annual seismic development for the last 3 years was approximately 3,369 ha. It was assumed that the same annual development rate occurred during 1996-2000 (3,369 ha X 5 years = 16,845 ha), which was applied to the area of previous seismic activities in the Fort Nelson TSA (i.e. eastern half of Fort Nelson totalling 5,726,268 ha).

Approximately 210 km of transmission lines have been identified in the eastern portion of the TSA. The transmission lines were buffered by 25 m as an approximation of one tree length from the power line or a 50 m right of way (ROW). The transmission maintenance technologist from BC Hydro confirmed that the average ROW is approximately 18 m[33]. Because the information for the ROW came too late in the process of GIS buffering of roads and seismic, it will be noted here that the reductions for transmission lines have been overestimated but would only slightly overestimate the timber harvesting land base reduction.

In summary, this process identified a total of 111,957 ha in the Fort Nelson TSA, which would be covered by transmission lines and affected by oil and gas activities (Table 65).

Table 65: Transmission lines, oil and gas activity reductions

Feature	Length (km)	Width (m)	Buffer used in GIS (m)	Total Area (ha)*	Net Area Excluded (ha)
Transmission lines (TRIM II)	209.79	50.0	25.0	1,050	147
Pipelines (OGC)	4,668.52	15	7.5	5,607	1,267
Pipelines (TRIM II)	1,518.08	15	7.5	2,236	451
Seismic (OGC) (2001-2003)	28,856.43	5	2.5	12,927	3,306
Seismic (TRIM II) (<1995)	105,604.21	7	3.5	73,292	16,736
Seismic non-spatial reduction (1996-2000)				16,845	4,119
Total				**111,957**	**26,026**

*The total area for each feature is the area within the buffer and does not account for overlap between other types of oil and gas features. Therefore, the sum of this column would be an overestimate of the true total area.

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[32] Based on seismic data for the Peace River region provided by OGC, the average width of seismic line was 6.47 m and 3.39 m for 1991 and 2003, respectively (period of analysis that the data was available for, which shows the trend in declining cut width over the past decade). Based on a meeting with the MoF and district staff (Dec. 16, 2003), it was decided that 7 metres is a reasonable width for seismic lines developed before 1995 and that an average 5 m width would be reflective of seismic widths for the 1996-2003 period. Based on an email correspondence with Grant Fox, Information Systems Manager, OGC, he estimated that the average right-of-way for pipelines in the TSA is approximately 15 m. Pipelines were extracted from TRIM and from a coverage provided by OGC.

[33] Telephone conversation with Micheal Bast, transmission maintenance technologist, BC Hydro. He estimates the width to be about 18.3m or about 9.15m buffer width (June 9, 2004).

It has been noted by the DFAM group that the 16,845 ha estimated for seismic disturbance during 1996 – 2000 may be overestimated. Without explicit data to support the calculation of seismic activity over this period of time, for the exception of the rate of disturbance provided by the OGC data (2000-2003), it is difficult to determine an appropriate estimate. While this assumption might overestimate the reduction for seismic activity, the magnitude of the difference is likely too small to have a significant impact on the timber harvesting land base. A sensitivity analysis is proposed to address the uncertainty of the timber harvesting land base size.

13.4.11 Inoperable/inaccessible/uneconomical areas

The assessment of operability is based on the anticipated extent to which a forested area within the Fort Nelson TSA will be harvested considering its physical and economical factors. Often, classifying operability includes a description of the timber quality, terrain conditions and cost and value of the timber. With the availability of new technologies harvesting is rarely impossible, but the related costs may be such that it is impractical.[34]

A revised operability analysis for the Fort Nelson TSA was developed based on the methodology from a 1997 harvest method mapping project undertaken in the Bulkley TSA[35]. The Fort Nelson operability analysis produced a spatial operability coverage for the entire TSA in which 'operable' polygons were identified through combinations of three derived attributes: stand quality codes, harvest method, and available land base. Queries were performed on the forest inventory to determine stand quality codes. Stand quality codes classified the stands into merchantability categories based on species, age, volume, diameter at breast height, and site index. Harvest method codes were defined by slope classes where ground based harvestable stands (< 35% slope) were considered to be available for harvest. The licensees are not pursuing cable or helicopter logging at this time. The available land base was defined as the available Crown forested land base. A combination of the merchantability criteria, harvest method and Crown productive forest was used to define the operability. Inoperable areas identified from this analysis are excluded from the timber harvesting land base (Table 66).

Table 66: Operable/inoperable classification

Operability Description	Total Area (ha)	% Reduction	Net Area Excluded (ha)
Operable	2,449,018	0	n/a
Inoperable	7,419,049	100	361,670

Given that this operability analysis was completed in a short timeline, there was not significant opportunity for a thorough review and critique. Several iterations of operability assessments were completed and provided to the DFAM group. Numerous reviews and meetings were held but no formal approval was received prior to completing the analysis dataset. It is proposed that several sensitivity analyses be completed regarding operability including testing the uneconomic criteria from TSR 2 and applying a transportation appraisal to the revised operability assessment.

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[34] from: http://www.for.gov.bc.ca/hcp/fia/landbase/OperabilityStandards.pdf

[35] from: http://www.for.gov.bc.ca/hcp/fia/landbase/HMM_OutlineBulkley.pdf

If any further information becomes available regarding operability during the course of this analysis it will be incorporated as necessary.

13.4.12 Black spruce-leading stands

Black spruce is typically harvested when occurring in mixed stands or in small pockets adjacent to other merchantable species; however, black spruce-leading stands are rarely targeted for timber harvesting in the Fort Nelson TSA.

Black spruce-leading stands contain small stem sizes, which are currently not considered merchantable, and offer regeneration problems for future stands due to elevated water tables. For the base case, all black spruce-leading stands will be excluded from the THLB (Table 67). The minor component of black spruce that occurs in mixed species stands will remain as part of the merchantable stand volume.

Table 67: Reduction to black-spruce leading stands

Description	% Reduction	Total Area (ha)	Net Area Excluded (ha)
Black spruce-leading stands	100	1,215,896*	143,258

* There are approximately 2,396,054 ha of black spruce leading stands in the Fort Nelson TSA from the inventory file. However, about 50% (1,179,617ha) have been assigned to the Non-Forest category for wetland and non-productive reductions based on attribute within the VRI

13.4.13 Cultural heritage resources

Three categories of cultural heritage resources are evident within the Fort Nelson TSA: archaeological sites containing physical remains of past human activity; historical sites often consisting of built structure or localities of events significant to living communities; and, traditional use sites which often lack the physical evidence of human-made artefacts or structures but maintain cultural significance for living communities. Natural heritage resources included in the Fort Nelson LRMP consist of all three types of cultural heritage resources.

An archaeological study, *Archaeological Overview of the Fort Nelson Land and Resource Management Plan Area, Heritage*, was completed in March 1996. The study was completed at a scale of 1:250 000 and classified the planning area into zones with a low, moderate or high potential to contain archaeological sites. This information has been refined to a scale of 1:50 000 or 1:20 000 to assist in operational decision-making.

The Muskwa-Kechika special management area (M-K SMA) covers approximately 6.4 million hectares, of which 2.3 million hectares overlap with the Fort Nelson TSA. The M-K SMA is composed of both special areas and protected areas. Protected areas, such as the historic Davie Trail, are removed from the THLB. Eleven new protected areas have been established, occupying more than 1 million hectares of land. Management in special areas is subject to the guidelines for management of special management zones as outlined in the Fort Nelson LRMP and will allow for logging activities that are sensitive to the wildlife, environmental and cultural values in the area. It is assumed that the wildlife and environmental rules and netdown provided in this data package will account for the Muskwa-Kechika special management requirements.

Trapping is a highly valued activity within the Fort Nelson TSA, particularly among First Nations communities whose families often maintain traplines. The LRMP identifies that, where traplines are not located in protected areas, a major concern for trappers is the need for adequate notice of pending development that might interfere with their traplines. This requires that any plan must co-ordinate access management planning to include the opportunity for participation by the trapline holder. Commercial/ industrial operators must work with trappers to minimize the impacts of their activities on furbearer habitat and trapline operations.

Currently there are no additional exclusions from the THLB for traplines or other cultural heritage resources.

13.4.14 Future roads, trails and seismic

A reduction for future roads, trails and seismic (RTS) activity is required to account for the resulting non-productive areas that will occur as access structures are built and logging and oil and gas activities occur. Future seismic activity is included in this reduction since seismic lines are often used for timber harvesting access.

To determine future requirements for roads, trails and seismic, a buffer of 200 m (total width of 400 m), representing the average yarding distance in the Fort Nelson TSA, will be spatially applied to all existing roads and seismic lines to determine the area currently accessed. The area inside the buffer will be considered the roaded area. All areas outside the buffer will be considered part of the non-roaded area. The area in road and seismic activities was determined to be approximately 3.9% of the THLB within the roaded-area (area in existing roads and seismic lines are described in Section 12.1.6 and 13.3.4). Assuming that the road-seismic density in the roaded area will also apply to the non-roaded area, a future RTS reduction will be applied to the THLB in the non-roaded area (Table 68).

Based on discussions with the DFAM group and confirmed by the MOF - Fort Nelson Forest District, roadside landings are used in the course of all current logging; additional reductions should therefore not be necessary since they would likely be incorporated into the future road widths. Any production landings within blocks are fully rehabilitated and regenerated and there is no further impact expected; therefore, no future in-block reductions will be made.

The DFAM group expects that future road requirements will remain similar to existing requirements throughout the THLB. The only exception is that the future area of seismic may not be applicable to the total non-roaded land base, but this is thought to be a conservative estimate.

***Please note that the future road reductions are based on the approved data package (July 9, 2004) where the current THLB was determined to be 1,432,257 ha and the CFLB to be 5,634,280 ha, a difference of 0.0008% and 1.86% from the current netdown, respectively. The netdown was revised because of an error found in the labelling of NP in the Non-Productive Descriptor in VRI, but changes to the future road and future WTPs reductions were not changed because it was agreed upon with the MoF timber supply analyst that these future reductions are not expected to be significantly different and that they did not justify the time required to redo such a lengthy analysis.*

Table 68: Future road reductions

Description	% Reduction	Reduction Applied to:	Net Area Excluded (ha)
Future between block structures (based on existing road density)	3.9	THLB in the "non-roaded" area	29,825

13.4.15 Future wildlife tree patches

After all other removals are completed, additional reductions are required to account for the amount of timber retention required for wildlife trees and wildlife tree patches (WTPs). Section 3.2 and Appendix 3 of the *Landscape Unit Planning Guide* (LUPG, updated in March 2000) will be the basis for modeling wildlife tree retention in this timber supply analysis. Further direction regarding the management of wildlife tree retention relates to the updated Section 3.2 provided by the Assistant Deputy Ministers of Environment, Lands and Parks[36] and Forests (May 2000) as well as the *Provincial Wildlife Tree Policy and Management Recommendations* (2002).

Wildlife tree targets are determined using Table 3.1 of the LUPG. The required wildlife tree retention %, to be applied to the THLB, was calculated by subtracting the THLB area requiring WTR from the WTR target. The results for this analysis are provided in Table 69. The process of determining the targets and THLB required for WTPs is described below:

Step 1
WTR requirements are calculated separately for each biogeoclimatic subzone within each landscape unit.

Step 2
The Crown forested area for all polygons within the TSA is identified. The current timber harvesting land base (THLB) is the total area remaining from the netdown process, excluding future roads and WTP requirements.

Step 3
The percentage of the BEC subzone within the landscape unit available for harvest is calculated as follows: (THLB/crown forested area)*100%.

Step 4
Estimate the portion of the THLB where previous harvesting does not meet WTR objectives. For the purposes of estimating this area, it is assumed that harvesting activities before the introduction of the *Biodiversity Guidebook* in 1995 do not meet WTR objectives.

Step 5
Based on the information derived from steps 1-3, total wildlife tree retention targets are determined from Table A3.2 in the revised Appendix 3 of the *Landscape Unit Planning Guide*.

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[36] Now the Ministry of Sustainable Resource Management

Step 6

Reserves such as riparian reserve zones contribute to wildlife tree retention targets. The *Landscape Unit Planning Guide* states that there should be no more than 500m between wildlife tree patches. To determine the proportion of the THLB requiring wildlife tree patches, a 250-meter GIS buffer is applied to existing non-harvestable contributing land base (defined as >80% retention). WTR targets are applied uniformly to the areas beyond the 250-meter buffer from existing reserves.

The results of the analysis show that an additional 6,272 ha of THLB will be required for future wildlife tree retention. Please note once again that the future WTP reductions are based on an older version of the netdown but the reductions are not expected to be very different (Section 13.4.14).

Table 69: Future wildlife tree retention required by landscape unit and BEC subzone

Landscape Unit	BEC Zone	BEC Subzone	Crown forest (ha)	THLB (ha)	% THLB harvested without WTP	% subzone available for harvest	WTP Target (%)	THLB Requiring WTP	Net Area Removed (ha)
July Lake	BWBS	mw	50,595	23,912	0.0	47.3	2	21,004	420
Shekilie	BWBS	mw	127,601	38,130	0.2	29.9	0	19,404	0
Timberwolf	BWBS	mw	66,769	37,748	0.0	56.5	3	25,326	760
Kyklo	BWBS	mw	144,883	67,545	1.1	46.6	2	33,252	665
Kwokullie	BWBS	mw	52,125	4,581	0.0	8.8	0	1,159	0
Hossitl	BWBS	mw	41,280	8,230	0.0	19.9	0	5,971	0
Ootta	BWBS	mw	46,551	7,824	0.0	16.8	0	2,702	0
Dilly	BWBS	mw	34,382	7,166	0.0	20.8	0	5,164	0
Sahtaneh	BWBS	mw	386,568	64,632	0.7	16.7	0	5,595	0
Hoffard	BWBS	mw	120,002	24,629	0.4	20.5	0	511	0
Elleh	BWBS	mw	77,393	25,505	0.2	33.0	0	4,428	0
Eskai	BWBS	mw	143,604	26,210	1.4	18.3	0	2,156	0
Klua	BWBS	mw	66,446	12,784	0.0	19.2	0	1,218	0
Klua	BWBS	wk	5,068	784	0.0	15.5	0	61	0
Big Beaver	BWBS	mw	93,481	20,567	0.7	22.0	0	1,847	0
Big Beaver	BWBS	wk	1,513	243	0.0	16.1	0	0	0
Snake	BWBS	mw	48,725	23,384	0.7	48.0	2	5,900	118
Kiwigana	BWBS	mw	197,588	85,146	0.0	43.1	1	21,758	218
D Easum	BWBS	mw	62,845	21,428	0.4	34.1	0	13,461	0
Sandy	BWBS	mw	27,370	15,980	1.7	58.4	3	9,249	277
Capot Blanc	BWBS	mw	38,661	22,800	5.7	59.0	4	10,314	413
Patry	BWBS	mw	67,448	26,058	4.3	38.6	1	5,847	58
Etane	BWBS	mw	46,370	24,574	3.4	53.0	2	2,704	54
Etane	BWBS	wk	342	160	0.0	46.8	2	0	0
Stanolind	BWBS	mw	93,763	36,395	0.9	38.8	1	5,129	51
Stanolind	BWBS	wk	216	190	0.0	87.9	6	73	4
Pouce	BWBS	mw	77,775	41,865	0.8	53.8	2	11,896	238
Pouce	BWBS	wk	275	132	0.0	48.1	2	7	0

Landscape Unit	BEC Zone	BEC Subzone	Crown forest (ha)	THLB (ha)	% THLB harvested without WTP	% subzone available for harvest	WTP Target (%)	THLB Requiring WTP	Net Area Removed (ha)
Akue	BWBS	mw	59,735	28,347	0.7	47.5	2	5,720	114
Akue	BWBS	wk	231	26	0.0	11.2	0	0	0
Klowee	BWBS	mw	49,386	19,357	2.7	39.2	1	3,096	31
Holden	BWBS	mw	94,592	21,091	0.0	22.3	0	1,709	0
Holden	BWBS	wk	17,431	871	0.0	5.0	0	8	0
Holden	SWB	mk	27,803	1,403	0.0	5.0	0	37	0
Jackknife	BWBS	mw	35,276	6,812	0.0	19.3	0	150	0
Minaker	BWBS	mw	66,377	15,559	0.0	23.4	0	1,733	0
Minaker	BWBS	wk	1,959	208	0.0	10.6	0	3	0
Minaker	SWB	mk	866	11	0.0	1.3	0	0	0
Richards	BWBS	mw	1,947	194	0.0	9.9	0	0	0
Richards	SWB	mk	24,292	601	0.0	2.5	0	84	0
Richards	SWB	mks	1,379	0	0.0	0.0	0	0	0
Hewer	BWBS	mw	2,263	172	0.0	7.6	0	6	0
Hewer	SWB	mk	31,269	336	0.0	1.1	0	19	0
Hewer	SWB	mks	1,128	0	0.0	0.0	0	0	0
Bunch	BWBS	mw	50,480	10,618	0.0	21.0	0	1,831	0
Bunch	BWBS	wk	2,793	102	0.0	3.7	0	0	0
Bunch	SWB	mk	5,859	25	0.0	0.4	0	0	0
Bunch	SWB	mks	2	0	0.0	0.0	0	0	0
Gammer	BWBS	mw	21,399	4,957	0.0	23.2	0	398	0
Gammer	BWBS	wk	576	47	0.0	8.2	0	2	0
Gammer	SWB	mk	6,465	237	0.0	3.7	0	0	0
Falk	BWBS	mw	91,040	13,813	0.0	15.2	0	4,918	0
Falk	SWB	mk	34,792	133	0.0	0.4	0	1	0
Falk	SWB	mks	37	0	0.0	0.0	0	0	0
Kledo	BWBS	mw	126,436	32,992	0.0	26.1	0	2,193	0
Kledo	BWBS	wk	20,201	2,005	0.0	9.9		99	0
Kledo	SWB	mk	38	0	0.0	0.0	0	0	0
Dunedin	BWBS	mw	65,892	11,881	0.0	18.0	0	5,233	0
Dunedin	BWBS	wk	2,002	49	0.0	2.4	0	7	0
Dunedin	SWB	mk	3,970	26	0.0	0.7	0	0	0
Dunedin	SWB	mks	4	0	0.0	0.0	0	0	0
Irene East	BWBS	mw	45,903	15,248	0.0	33.2	0	2,955	0
Irene West	BWBS	mw	84,730	35,215	0.0	41.6	1	11,889	119
Irene West	BWBS	wk	1,273	274	0.0	21.5	0	65	0
Catkin	BWBS	mw	30,864	22,038	0.0	71.4	4	12,955	518
La Biche	BWBS	mw	62,965	33,295	10.9	52.9	2	12,169	243
Crow	BWBS	mw	65,171	24,090	6.1	37.0	2	14,991	300
Crow	BWBS	wk	4,433	39	0.0	0.9	0	0	0
Crow	SWB	mk	1,170	0	0.0	0.0	0	0	0
Scatter	BWBS	mw	34,784	1,930	0.0	5.5	0	748	0
Scatter	BWBS	wk	32,279	1,855	0.0	5.7	0	374	0
Scatter	SWB	mk	33,020	191	0.0	0.6	0	5	0

Landscape Unit	BEC Zone	BEC Subzone	Crown forest (ha)	THLB (ha)	% THLB harvested without WTP	% subzone available for harvest	WTP Target (%)	THLB Requiring WTP	Net Area Removed (ha)
Scatter	SWB	mks	54	0	0.0	0.0	0	0	0
Graybank	BWBS	dk	2,432	0	0.0	0.0	0	0	0
Graybank	BWBS	mw	43,721	18,095	0.0	41.4	1	12,006	120
Graybank	BWBS	wk	7,764	3,016	0.0	38.8	1	1,775	18
Graybank	SWB	mk	4,988	470	0.0	9.4	0	270	0
Crusty	BWBS	mw	25,271	6,160	0.0	24.4	0	2,764	0
Crusty	SWB	mk	3,590	12	0.0	0.3	0	0	0
Ram	BWBS	mw	14,837	1,736	0.0	11.7	0	536	0
Ram	SWB	mk	23,083	298	0.0	1.3	0	46	0
Ram	SWB	mks	67	0	0.0	0.0	0	0	0
Tetsa	BWBS	mw	178	0	0.0	0.0	0	0	0
Tetsa	SWB	mk	19,925	15	0.0	0.1	0	0	0
Tetsa	SWB	mks	640	0	0.0	0.0	0	0	0
Tuchodi	BWBS	mw	4,272	0	0.0	0.0	0	0	0
Tuchodi	SWB	mk	58,704	0	0.0	0.0	0	0	0
Tuchodi	SWB	mks	2,718	0	0.0	0.0	0	0	0
Gathto	BWBS	mw	553	0	0.0	0.0	0	0	0
Gathto	SWB	mk	18,034	0	0.0	0.0	0	0	0
Gathto	SWB	mks	739	0	0.0	0.0	0	0	0
Crehan	BWBS	mw	6,369	55	0.0	0.9	0	0	0
Crehan	SWB	mk	27,435	0	0.0	0.0	0	0	0
Crehan	SWB	mks	564	0	0.0	0.0	0	0	0
Racing	SWB	mk	13,712	44	0.0	0.3	0	10	0
Racing	SWB	mks	588	0	0.0	0.0	0	0	0
MacDonald	BWBS	mw	2,710	160	0.0	5.9	0	1	0
MacDonald	SWB	mk	20,873	2,469	0.0	11.8	0	780	0
MacDonald	SWB	mks	96	0	0.0	0.0	0	0	0
Tentsi	BWBS	mw	6,219	788	0.0	12.7	0	175	0
Tentsi	SWB	mk	19,781	4,083	0.0	20.6	0	2,742	0
Tentsi	SWB	mks	3	0	0.0	0.0	0	0	0
Moose	SWB	mk	15,051	2,634	0.0	17.5	0	1,523	0
Moose	SWB	mks	84	0	0.0	0.0	0	0	0
Otelsas	BWBS	mw	343	0	0.0	0.0	0	0	0
Otelsas	SWB	mk	22,011	288	0.0	1.3	0	66	0
Otelsas	SWB	mks	983	0	0.0	0.0	0	0	0
Muncho	BWBS	dk	10,914	125	0.0	1.1	0	0	0
Muncho	SWB	mk	29,799	140	0.0	0.5	0	61	0
Muncho	SWB	mks	1,711	0	0.0	0.0	0	0	0
Eight Mile	BWBS	mw	10,802	522	0.0	4.8	0	173	0
Eight Mile	SWB	mk	33,947	911	0.0	2.7	0	254	0
Eight Mile	SWB	mks	46	0	0.0	0.0	0	0	0
Sulpher	BWBS	dk	32,954	637	0.0	1.9	0	113	0
Sulpher	BWBS	mw	745	0	0.0	0.0	0	0	0
Sulpher	SWB	mk	22,728	668	0.0	2.9	0	67	0

Landscape Unit	BEC Zone	BEC Subzone	Crown forest (ha)	THLB (ha)	% THLB harvested without WTP	% subzone available for harvest	WTP Target (%)	THLB Requiring WTP	Net Area Removed (ha)
Sulpher	SWB	mks	22	0	0.0	0.0	0	0	0
Moule	BWBS	dk	32,240	531	0.0	1.6	0	22	0
Moule	BWBS	wk	139	0	0.0	0.0	0	0	0
Moule	SWB	mk	11,162	851	0.0	7.6	0	214	0
Moule	SWB	mks	97	1	0.0	0.9	0	0	0
Grayling	BWBS	dk	28	20	0.0	70.4	4	0	0
Grayling	BWBS	mw	22,699	5,356	0.0	23.6	0	2,649	0
Grayling	BWBS	wk	22,423	5,991	0.0	26.7	0	2,423	0
Grayling	SWB	mk	72,604	9,150	0.0	12.6	0	4,316	0
Grayling	SWB	mks	1,188	57	0.0	4.8	0	31	0
Redpott	BWBS	mw	184	82	0.0	44.6	1	13	0
Redpott	BWBS	wk	6,473	1,902	0.0	29.4	0	823	0
Redpott	SWB	mk	26,010	3,821	0.0	14.7	0	1,999	0
Redpott	SWB	mks	9	1	0.0	11.5	0	1	0
Smith	BWBS	dk	140,711	57,613	0.0	40.9	1	39,343	393
Smith	BWBS	wk	994	594	0.0	59.8	3	511	15
Smith	SWB	mk	23,164	3,580	0.0	15.5	0	1,783	0
Liard Hot Springs	BWBS	dk	33,565	4,135	0.0	12.3	0	1,952	0
Liard Hot Springs	SWB	mk	12,225	145	0.0	1.2	0	13	0
Liard Hot Springs	SWB	mks	8	0	0.0	0.0	0	0	0
Forcier	BWBS	dk	23,439	430	0.0	1.8	0	114	0
Forcier	SWB	mk	14,640	373	0.0	2.5	0	96	0
Forcier	SWB	mks	1,332	4	0.0	0.3	0	0	0
Vents	BWBS	dk	61,415	17,724	0.0	28.9	0	11,125	0
Vents	SWB	mk	29,459	2,839	0.0	9.6	0	1,545	0
Vents	SWB	mks	392	0	0.0	0.0	0	0	0
Liard River A	BWBS	dk	115,668	21,495	0.0	18.6	0	12,217	0
Liard River A	SWB	mk	2,691	114	0.0	4.3	0	1	0
Liard River B	BWBS	mw	31,650	7,870	0.0	24.9	0	2,060	0
Liard River B	BWBS	wk	38	2	0.0	5.2	0	0	0
Liard River C	BWBS	mw	67,086	42,647	5.5	63.6	3	15,498	465
Fort Nelson River B	BWBS	mw	35,336	20,521	0.0	58.1	3	3,334	100
Fort Nelson River A	BWBS	mw	20,364	10,061	0.1	49.4	2	1,289	26
Muskwa River B	BWBS	mw	27,010	12,853	0.0	47.6	2	1,456	29
Prophet River	BWBS	mw	27,092	15,279	0.2	56.4	3	2,193	66
Muskwa River A	BWBS	mw	16,944	3,286	0.0	19.4	0	75	0
Muskwa River A	SWB	mk	1,632	0	0.0	0.0	0	0	0
Hay River	BWBS	mw	6,545	2,953	0.0	45.1	2	637	13
Petitot River	BWBS	mw	13,392	2,739	0.0	20.5	0	528	0
Kechika River	BWBS	dk	165,000	57,519	0.0	34.9	1	26,912	269
Kechika River	SWB	mk	18,246	3,005	0.0	16.5	0	882	0
Coal	BWBS	dk	60,587	13,954	0.0	23.0	0	8,621	0
Coal	SWB	mk	3,051	278	0.0	9.1	0	121	0
Kitza	BWBS	dk	19,700	9,973	0.0	50.6	2	6,752	135

Landscape Unit	BEC Zone	BEC Subzone	Crown forest (ha)	THLB (ha)	% THLB harvested without WTP	% subzone available for harvest	WTP Target (%)	THLB Requiring WTP	Net Area Removed (ha)
Kitza	SWB	mk	921	170	0.0	18.5	0	43	0
Gemini	BWBS	dk	39,842	6,213	0.0	15.6	0	1,918	0
Gemini	SWB	mk	926	37	0.0	4.0	0	8	0
Rabbit	BWBS	dk	60,632	7,900	0.0	13.0	0	2,518	0
Rabbit	SWB	mk	16,614	1,035	0.0	6.2	0	250	0
Chee	BWBS	dk	17,220	490	0.0	2.8	0	38	0
Chee	SWB	mk	33,423	3,073	0.0	9.2	0	1,577	0
Chee	SWB	mks	145	71	0.0	48.6	2	71	1
Gundahoo	BWBS	dk	3,875	941	0.0	24.3	0	333	0
Gundahoo	SWB	mk	46,856	3,897	0.0	8.3	0	1,679	0
Gundahoo	SWB	mks	5,064	25	0.0	0.5	0	0	0
Netson	BWBS	dk	10,641	3,904	0.0	36.7	1	1,873	19
Netson	SWB	mk	68,378	10,117	0.0	14.8	0	5,345	0
Netson	SWB	mks	6,199	294	0.0	4.7	0	193	0
Matulka	BWBS	dk	4,821	748	0.0	15.5	0	354	0
Matulka	SWB	mk	12,152	326	0.0	2.7	0	125	0
Matulka	SWB	mks	1,374	15	0.0	1.1	0	1	0
Boreal	BWBS	dk	19,441	2,626	0.0	13.5	0	922	0
Boreal	SWB	mk	51,882	4,010	0.0	7.7	0	1,972	0
Boreal	SWB	mks	6,009	6	0.0	0.1	0	0	0
Major Hart	BWBS	dk	43,791	12,952	0.0	29.6	0	5,797	0
Major Hart	SWB	mk	84,008	8,016	0.0	9.5	0	3,090	0
Major Hart	SWB	mks	3,239	65	0.0	2.0	0	8	0
Sharktooth	BWBS	dk	14,661	3,527	0.0	24.1	0	1,500	0
Sharktooth	SWB	mk	35,433	4,053	0.0	11.4	0	2,058	0
Sharktooth	SWB	mks	1,891	18	0.0	1.0	0	17	0
Total			**5,634,280**	**1,432,257**				**506,135**	**6,272**

14 Management zones and analysis units

14.1 Management zones and objectives

Management zones are used to differentiate areas with distinct management emphasis for the application of forest cover rules in the timber supply analysis, and reporting purposes.

The concept of management zones is used to distinguish areas with distinct management emphasis and homogeneous forest cover. For example, a zone may be based on a harvesting system, silviculture system, visual quality objective, wildlife consideration, or similar forest cover data. Zones may be thought of as layers required for different management objectives, which must be maintained and tracked over time. Seven management zones have been identified for the Fort Nelson TSA (Table 70).

Table 70: Resource emphasis zones in the Fort Nelson TSA

Resource Emphasis Zone	Total area (ha)	Crown forested land base area (ha)	Timber harvesting land base area (ha)
Enhanced Resource Development Zone	3,707,023	2,090,155	613,027
General Resource Zone	2,317,692	1,899,556	591,633
Muskwa-Kechika Special Management Zone	2,354,719	1,387,202	225,327
Visual Quality Objectives	807,877	603,692	175,005
Biodiversity Low Emphases	5,145,364	2,544,749	565,834
Biodiversity Intermediate Emphases	4,193,641	2,781,553	715,818
Biodiversity High Emphases	529,059	414,909	150,617

The Enhanced Resource Development Zone (ERDZ), General Resource Zone (GRZ), and Muskwa-Kechika Special Management Zone (M-KSMZ) are described by the *Fort Nelson LRMP* (1997). The objectives of the ERDZ include managing the land for oil and gas, and mineral and timber resources, while emphasizing recreation and tourism resources along the highway corridor; moreover, investments in resource development are encouraged. The intent of the GRZ is to manage for a wide array of resource values by integrating the requirements of these values with resource development. The management direction of M-KSMZ is that resource development can proceed while minimizing impacts on other resource values. The M-KSMZ contains the most restrictive objectives and strategies for development.

14.2 Analysis units

An analysis unit represents a combination of stands dominated by specific tree species, or a silviculture regime with a set range of timber growing capability – as indicated by the species and site index in the forest inventory file. Inventory stand groups define the primary analysis units and site index (SI) defines the secondary analysis units, whereby natural groupings of SI were determined by means of SI distribution analysis (Table 71). Each analysis unit is assigned its own net merchantable volume projections for existing and future stands.

Table 71: Primary and secondary analysis units for the Fort Nelson TSA

Primary Analysis Unit	Secondary Analysis Unit*	Leading Species	Inventory Type Group	Site Index Range
1	011	Spruce	21, 23, 24	< 14.5
1	012			14.5 – 17.9
1	013			> 17.9
2	021	Spruce/pine	25	< 13.1
2	022			13.1 – 16.9
2	023			> 16.9
3	031	Spruce/deciduous	26	< 13.2
3	032			13.2 – 17.9
3	033			> 17.9
4	041	Aspen/coniferous	41	< 18.2
4	042			18.2 – 22.0
4	043			> 22.0
5	051	Aspen/deciduous	42	< 18.2
5	052			18.2 – 23.3
5	053			> 23.3
6	061	Pine	27-30	< 14.1
6	062			14.1 – 18.4
6	063			> 18.4
7	071	Pine/deciduous	31	< 14.3
7	072			14.3 – 18.4
7	073			> 18.4
8	081	Cottonwood/coniferous	35	< 16.2
8	082			16.3 – 22.2
8	083			> 22.2
9	091	Cottonwood/deciduous	36	< 16.1
9	092			16.1 – 23.1
9	093			> 23.1
10	101	Spruce/larch	22	< 14.0
10	102			14.0 – 18.0
10	103			> 18.0
11	111	Subalpine fir	18-20	< 11.0
11	112			11.0 – 14.5
11	113			> 14.5
12	121	Birch**	40	< 18.3
12	122			18.3 – 20.9
12	123			> 20.9

*The naming convention of the secondary analysis unit is where the first two digits are the primary analysis unit and the third digit is 1=low SI, 2 =medium SI, and 3 =high SI.

**Birch is used for sensitivity analysis only.

The analysis units will be organized within the following management groups:

Existing natural stands – stands that have not been logged yet or are not subject to forest management (planting/density control). This group will include current and future deciduous and naturally regenerating mixedwood spruce/larch and subalpine fir stands. Any stands logged pre-1990 are also considered 'natural'. These stands will be modeled with VDYP, as agreed to by the DFAM/District, as they are problematic and of low productivity: there is difficulty regenerating these stands, as represented by their longer regeneration delay.

Existing natural stand analysis units are presented in Table 72. Each analysis unit will also be split between VRI "rolled over" and VRI Phase II to recognize the differences between these inventory standards as well as for analysis comparison and modelling.

Existing managed stands –stands that have been subject to forest management (planting and density control) to the degree that they would exhibit different growth characteristics and attributes as compared to existing natural stands. Existing managed stands include stands harvested between 1990 and 2002. Only pure spruce, spruce/pine and pure pine stands are planted so it is expected that they will form the majority of existing managed stands. These stands will be modelled using TIPSY. As the existing managed pure conifer stands are harvested they will regenerate to future managed stands.

Current/future managed stands – stands that are currently being harvested and regenerated following current forest management (*i.e.* any stand logged or managed after 2003). Once the pure spruce, spruce/pine and pure pine existing natural and existing managed stands are harvested they will regenerate to pure conifer future managed stands. Future managed stands will be modelled using TIPSY. The difference between existing managed and current/future managed stands is that the latter will be modelled with genetic gain information applied to the yield curves.

Analysis units for existing natural stands (Table 72), existing managed stands (Table 73), and future managed stands (Table 74) are split between VRI "rolled over" and Phase II to represent the differences between these inventory standards. The SI values provided represent area-weighted averages for these stands.

Table 72: Existing natural stand primary analysis unit and site index

Primary Analysis Units	Secondary Analysis Units	Area-weighted SI based on VRI “rolled over"	Area-weighted SI based on VRI Phase II
1	011	12.22	12.81
1	012	15.73	15.90
1	013	19.43	19.81
2	021	11.39	12.24
2	022	14.95	14.58
2	023	21.38	19.40
3	031	11.60	12.18
3	032	14.98	15.41
3	033	20.65	19.97
4	041	16.48	16.87
4	042	19.57	20.04
4	043	23.32	23.47
5	051	17.12	17.08
5	052	20.40	20.39
5	053	24.98	24.59
6	061	11.58	12.25
6	062	15.95	16.06
6	063	19.92	20.04
7	071	11.40	13.08
7	072	15.82	16.37
7	073	20.12	20.46
8	081	15.13	15.19
8	082	18.51	18.69
8	083	24.29	26.48
9	091	15.16	15.01
9	092	18.85	19.30
9	093	25.03	27.81
10	101	11.71	12.30
10	102	15.24	15.55
10	103	24.72	20.92
11	111	8.56	9.68
11	112	12.95	13.50
11	113	17.46	16.37
12	121	12.28	14.27
12	122	19.57	19.36
12	123	24.16	23.00

*Birch is used for sensitivity analysis only.

Table 73: Existing managed stand analysis unit and site index

Primary Analysis Units	Secondary Analysis Units	Area-weighted SI based on VRI "rolled over"
1	012	15.27
6	062	17.35
6	063	20.00

Note: Only existing managed stands in the THLB are shown.

Table 74: Current/future managed stand analysis unit and site index

Primary Analysis Units	Secondary Analysis Units	Area-weighted SI based on VRI "rolled over"	Area-weighted SI based on VRI Phase II
1	011	12.22	12.81
1	012	15.73	15.90
1	013	19.43	19.81
2	021	11.39	12.24
2	022	14.95	14.58
2	023	21.38	19.40
6	061	11.58	12.25
6	062	15.95	16.06
6	063	19.92	20.04

15 Growth and Yield

This section describes the issues, information sources and assumptions, and methods related to growth and yield estimates for existing and future stands under both unmanaged and managed conditions in the Fort Nelson TSA.

15.1 Site index

Site index is a measure of the productive capacity of a given site to sustain the growth of trees to harvestable age. It is a key variable in predicting the growth of timber and its yield at harvest. Site index is defined as the height of a "site" tree at 50 years breast height age.

15.1.1 Site curves

Site index curves are used to define the correlation between stand age and height. This analysis will use those curves that are consistent with the accepted MOF standards. The site index sources are shown in Table 75.

Table 75: Source of site index equations

Species	Code	Site Curve Reference
White spruce	Sw	Goudie (1984)
Spruce	S	Goudie (1984)
Aspen	At	Alberta Forest Service (1985)
Lodgepole pine	Pl	Nigh (1999)
Cottonwood	Ac	J.S. Thrower and Associates (1992)
Larch	L	Milner (1989)
Subalpine fir	Bl	Goudie (1984)
Birch	Ep	Alberta Forest Service (1985)

15.1.2 Site index adjustments

No site index adjustments are planned for the base case. VRI Phase 2 inventory adjustments are incorporated in the inventory data and will be used in the base case.

As noted in Section 12.1.2, there is a variety of PEM and TEM data that exists for the Fort Nelson TSA but there are no independent accuracy assessments available. Therefore, a sensitivity analysis will be completed to quantify the impacts of using associations between ecological data and site productivity. The site index for all managed stands will be adjusted for the sensitivity analysis using the following methodology:

1. Overlay forest cover (leading species) and analysis units and PEM data to create SIBEC groups.
2. Generate site series distribution by BEC variant by analysis unit.
3. Develop an area weighted SIBEC site index estimate for each species by SIBEC group.

4. Once the adjusted site index estimates are known, the managed stand polygons can be adjusted by selecting the appropriate curve from the next highest SI grouping from the base case managed stand yield curves. If new managed yield stand curves are required, the adjusted site index estimates will be applied in TIPSY using the appropriate analysis unit inputs.

15.2 Utilization level

The development of the yield curves will include a standard utilization to define the maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (dbh) by species (Table 76). These factors are used to define and calculate merchantable volume.

Table 76: Minimum utilization levels

Leading Species	Minimum dbh (cm)	Maximum Stump Height (cm)	Minimum top dib (cm)
Spruce	17.5	30	10
Pine	12.5	30	10
Subalpine fir	17.5	30	10
Cottonwood	12.5	30	10
Aspen	12.5	30	10
Larch*	17.5	30	10
Birch*	12.5	30	10

* Larch and birch are provided since they will be utilized as minor components of other leading species stands.

15.3 Decay, waste and breakage for unmanaged stands

Decay, waste and breakage factors by species are applied to unmanaged stand yield tables to calculate net volumes per hectare. The factors that will be used are the standard values that are included in the Variable Density Yield Prediction (VDYP) model.

15.4 Operational adjustment factors for managed stands

This section describes all operational adjustment factors (OAFs) that need to be applied to reduce potential yields generated by the Table Interpolation Program for Stand Yields (TIPSY) for managed stands, to better reflect expected operational yields.

The provincial default factors are an OAF 1 of 15% and an OAF 2 of 5%. OAF 1 includes accounting for openings in stands (4%), distribution of stems or clumpiness (4%), endemic pests and diseases (4%), and other risks to potential yield (3%) for a total of 15%.

OAF 2 is applied to account for decay, waste and breakage. The 5% factor originates from estimates for older immature stands documented in the *1976 Metric Diameter Class Decay, Waste and Breakage Factors*. OAF 2 is applied after OAF 1 and increases over time from 0% at time 0 years to 5% at index age of 100 years. The reduction increases linearly at this rate (10% at 200 years, 15% at 300 years etc).

The standard provincial OAF values currently represent best available information for the Fort Nelson TSA to account for stand gaps, decay, waste and breakage, and endemic forest health losses.

15.5 Volume reductions

Volume reductions are used in timber supply analysis to account for non-merchantable components of otherwise merchantable stands. A stand may contain one or more species, which may be non-merchantable, and should therefore not contribute to the estimated volume of the stand for timber supply analysis. Table 77 indicates the species to be excluded from the estimated stand volumes.

Table 77: Non-merchantable species volume exclusions

Species	Volume exclusion (%)
Alder/maple	100
Douglas-fir	100
Hemlock	100
Cedar	100

15.6 Other issues related to yield table development

Yield curves for unmanaged, existing managed, and current/future stands are shown in Appendix 6. Sections 15.6.1 to 15.6.3 describe the models that will be used for growth and yield in this analysis.

15.6.1 Yields for Natural (Unmanaged) Stands

Yield tables for mature and unmanaged immature stands were predicted with BatchVDYP version 6.6d. The yield tables will be generated by creating a yield table for each polygon then using an area weighted function to develop an aggregate table for each AU.

15.6.2 Yields for Existing Managed Stands

Spruce, spruce/pine and pine stands which have been regenerated from 1990 – 2001 will be grown on managed stand yield tables (MSYTs) produced using the B.C. Forest Service Table Interpolation Program for Stand Yields (TIPSY ver. 3.0h) growth and yield model.

15.6.3 Yields for Current and Future Managed Stands

Spruce, spruce/pine and pine stands which have been regenerated from 2002 onwards will be grown on MSYTs produced using the B.C. Ministry of Forests TIPSY ver. 3.0h growth and yield model. Any current or future genetic gain benefits will be applicable to these stands.

15.6.4 Existing timber volume check

To test that the growth and yield inputs were developed appropriately and that no errors were made in aggregation and no significant bias exists, an existing timber volume check was completed. This comparison investigates the difference between polygon-specific volume of the total volume obtained from the current inventory and the total volume derived from VDYP/TIPSY yield curves (Table 78 and Table 79). Where the volume difference seems to be large, they are associated with the managed stand tables, a small THLB area, and/or younger age classes. Differences of less than 3% are within the current DFAM standards and are considered adequate for modeling timber supply. This comparison illustrates that the analysis unit assumptions are appropriate as the difference is only 0.44 %.

Table 78: Existing timber volume check by secondary analysis unit

Stand Management Type	VRI Standard	Secondary Analysis Unit	THLB (ha)	Total Inventory Volume	Total Yield Volume	Difference (m3)	% Difference from Inventory Volume
Existing managed	Rolled over	12	4,897	0	0	0	0.00
		13	1	0	0	0	0.00
		62	63	0	451	451	
		63	273	0	0	0	0.00
Existing natural	Phase 2	11	45,194	7,975,100	7,888,013	-87,087	-1.09
		12	38,400	7,373,579	7,289,634	-83,945	-1.14
		13	14,092	2,138,036	2,160,857	22,821	1.07
		21	3,128	470,481	468,435	-2,046	-0.43
		22	6,265	1,023,683	1,035,921	12,238	1.20
		23	2,246	253,744	264,079	10,336	4.07
		31	17,784	2,638,824	2,582,552	-56,272	-2.13
		32	63,853	10,453,890	10,340,356	-113,534	-1.09
		33	25,598	3,233,840	3,302,892	69,052	2.14
		41	37,348	4,973,081	4,824,711	-148,369	-2.98
		42	74,797	18,404,912	18,131,506	-273,406	-1.49
		43	23,984	8,136,469	8,076,215	-60,254	-0.74
		51	60,840	6,761,850	6,546,716	-215,134	-3.18
		52	179,943	38,165,370	37,589,081	-576,289	-1.51
		53	37,416	10,440,999	10,338,551	-102,448	-0.98
		61	18,247	3,568,572	3,574,374	5,802	0.16
		62	16,474	3,521,636	3,556,367	34,731	0.99
		63	2,705	653,541	657,278	3,736	0.57
		71	3,745	658,685	658,563	-122	-0.02
		72	10,133	1,819,298	1,838,103	18,805	1.03
		73	3,684	765,900	757,708	-8,192	-1.07

Stand Management Type	VRI Standard	Secondary Analysis Unit	THLB (ha)	Total Inventory Volume	Total Yield Volume	Difference (m3)	% Difference from Inventory Volume
		81	1,325	194,708	200,101	5,394	2.77
		82	3,012	506,743	510,995	4,252	0.84
		83	2,009	598,935	599,414	479	0.08
		91	2,641	249,026	249,327	302	0.12
		92	11,590	1,774,444	1,787,806	13,362	0.75
		93	6,264	2,141,561	2,135,105	-6,456	-0.30
		101	497	56,646	55,920	-726	-1.28
		102	752	108,758	106,464	-2,294	-2.11
		103	164	12,690	13,878	1,189	9.37
		111	45	5,751	5,720	-31	-0.55
Existing natural	Rolled over	11	83,550	16,137,255	16,300,766	163,512	1.01
		12	45,503	10,031,458	9,985,389	-46,070	-0.46
		13	20,062	3,910,156	3,870,815	-39,341	-1.01
		21	15,893	2,771,625	2,784,138	12,514	0.45
		22	9,102	2,208,768	2,225,226	16,457	0.75
		23	1,941	254,123	257,672	3,549	1.40
		31	21,373	3,374,109	3,372,907	-1,202	-0.04
		32	41,315	9,577,856	9,525,831	-52,024	-0.54
		33	8,287	1,503,996	1,531,797	27,801	1.85
		41	15,252	3,188,567	3,154,773	-33,794	-1.06
		42	26,083	6,055,037	6,064,909	9,872	0.16
		43	8,435	2,511,180	2,495,008	-16,172	-0.64
		51	25,501	3,045,423	2,961,501	-83,922	-2.76
		52	76,071	16,192,805	16,157,547	-35,258	-0.22
		53	9,587	3,165,554	3,163,702	-1,853	-0.06
		61	168,036	29,340,770	29,624,894	284,124	0.97
		62	52,669	11,984,248	12,067,458	83,210	0.69
		63	32,225	5,700,950	5,652,629	-48,321	-0.85
		71	5,728	930,383	934,811	4,428	0.48
		72	15,803	3,342,337	3,376,666	34,329	1.03
		73	6,827	767,222	770,521	3,300	0.43
		81	673	156,249	154,828	-1,421	-0.91
		82	2,020	475,632	478,142	2,510	0.53
		83	341	70,560	76,801	6,241	8.84
		91	1,830	357,238	353,150	-4,088	-1.14
		92	10,350	2,331,686	2,328,599	-3,086	-0.13
		93	696	204,658	205,682	1,023	0.50
		101	227	40,641	39,012	-1,629	-4.01
		102	291	65,917	56,488	-9,428	-14.30
		103	73	22,536	22,556	20	0.09
		111	3,656	586,161	600,996	14,835	2.53
		112	2,619	429,485	428,484	-1,001	-0.23
		113	841	56,493	59,820	3,327	5.89
Total:			**1,432,269**	**279,871,824**	**278,630,611**	**-1,241,214**	**-0.44**

Table 79: Existing timber volume check by age class

Stand Management Type	10 Year Age Class	THLB (ha)	Total Inventory Volume	Total Yield Volume	Difference (m3)	% Difference from Inventory Volume
Existing managed	0	1,347	0	0	0	0.00
	10	2,551	0	0	0	0.00
	20	682	0	0	0	0.00
	30	653	0	451	451	
Existing natural	0	6,064	0	0	0	0.00
	10	25,334	0	0	0	0.00
	20	23,909	1,847	6,180	4,333	234.61
	30	22,489	192,468	267,201	74,733	38.83
	40	47,171	2,495,001	2,416,309	-78,691	-3.15
	50	107,005	9,993,930	10,145,514	151,584	1.52
	60	122,132	16,963,050	16,209,272	-753,778	-4.44
	70	48,890	8,106,385	7,869,511	-236,874	-2.92
	80	89,084	15,665,476	15,240,793	-424,683	-2.71
	90	62,431	13,973,931	13,974,489	558	0.00
	100	294,395	69,571,121	66,820,708	-2,750,413	-3.95
	110	111,695	31,556,847	30,880,432	-676,415	-2.14
	120	235,760	50,698,619	52,637,025	1,938,406	3.82
	130	43,336	11,320,606	11,211,321	-109,285	-0.97
	140	107,462	25,139,560	26,506,878	1,367,318	5.44
	150	15,831	4,570,634	4,607,653	37,019	0.81
	160	33,574	9,744,978	9,868,576	123,598	1.27
	170	7,367	2,412,376	2,401,587	-10,789	-0.45
	180	5,897	1,939,774	1,997,420	57,645	2.97
	190	4,794	1,672,178	1,670,607	-1,570	-0.09
	200	1,539	561,299	558,127	-3,171	-0.56
	210	2,204	756,646	779,187	22,541	2.98
	220	1,060	412,353	397,177	-15,175	-3.68
	230	6,665	1,759,570	1,803,948	44,378	2.52
	240	633	236,654	230,438	-6,216	-2.63
	250	112	44,682	47,801	3,118	6.98
	260	100	36,268	36,919	651	1.80
	270	104	45,573	45,086	-487	-1.07
Total:		**1,432,269**	**279,871,824**	**278,630,611**	**-1,241,214**	**-0.44**

16 Silviculture

16.1 Silviculture management regimes

16.1.1 Unmanaged Stands

In the Fort Nelson TSA, unmanaged stands will be defined as all stands disturbed by fire and/or harvest prior to and including 1989, and all existing stands excluding pure pine, pure spruce and spruce/pine stands (i.e. analysis units 1, 2, and 6). Licensees and district staff felt that although some planting and density control was done between 1987 and 1989, it was not until 1990 and onwards that there was adequate planting and brush control in the TSA.

Therefore, unmanaged stands (i.e. stands that have not been harvested or managed since 1990) will be grown on unmanaged stand (VDYP) yield curves for several reasons:

1) Although some stands may have been planted prior to 1990, it is assumed that the lower volumes produced by VDYP yield curves (as compared to TIPSY curves) will more accurately reflect the management regimes and expected yield of these stands.

2) Modelling natural regeneration of these stands also reflects the longer regeneration delays compared to 'managed' stands and, in some cases, the lack of brush control in these stands.

3) Some of these stands have not been planted.

For the analysis, all stands harvested prior to 1990 will be naturally regenerated and will be grown on unmanaged stand yield tables, including pine, spruce, and pine/spruce. Existing stands of pure deciduous, spruce/deciduous, pine/deciduous, subalpine fir, spruce/larch, aspen/coniferous, aspen/deciduous, cottonwood/coniferous, cottonwood/deciduous and birch, whether harvested in the past or in the future, will be modelled using VDYP generated yield curves (Table 80).

Table 80: Unmanaged stand regeneration assumptions for existing stands and all stands harvested prior to 1990

Analysis Unit #	Species	Future AU*	Future Regeneration Delay*	Future Regeneration Method	%	Species	%
1	Spruce	N/A	N/A	Planted	100	Spruce	100
2	Spruce/pine	N/A	N/A	Planted	100	Spruce/pine	100
3	Spruce/deciduous	Same	4	Natural	100	Spruce/deciduous	100
4	Aspen/coniferous	Same	1	Natural	100	Aspen/coniferous	100
5	Aspen/deciduous	Same	1	Natural	100	Aspen/deciduous	100
6	Pine	N/A	N/A	Planted	90	Pine	90
			4	Natural	10	Pine	10
7	Pine/deciduous	Same	4	Natural	100	Pine/deciduous	100
8	Cottonwood/ coniferous	Same	1	Natural	100	Cottonwood/ coniferous	100
9	Cottonwood/ deciduous	Same	1	Natural	100	Cottonwood/ deciduous	100
12	Birch	Same	4	Natural	100	Birch	100
10	Spruce/larch	Same	4	Natural	100	Spruce/larch	100
11	Subalpine fir	Same	4	Natural	100	Subalpine fir	100

* For existing stands and stands harvested prior to 1990 in Analysis Units 1, 2, and 6, they are currently following a natural stand yield curve but after harvest, they will be follow a managed stand yield curve (Section 16.1.2).

Regeneration delay is the time elapsed between the harvest date and the time when stand growth begins. The delay incorporates both the time taken to establish a stand, and the age of seedling stock planted or naturally regenerated. The regeneration delays provided were discussed with the DFAM group and the Fort Nelson Forest District and are considered representative given the variability that some stands have been planted, some have been brushed and others regenerated naturally. Spruce/larch and subalpine stands are often associated with high water table and problematic regeneration. Therefore, the DFAM Group felt it would be appropriate to model the spruce/larch and subalpine stands using VDYP as TIPSY would overestimate the volume. For pure pine stands, 90% of the stand will be planted according to assumptions on Table 81 and 10% of the stand will be naturally regenerated.

16.1.2 Managed Stands

16.1.2.1 Existing managed stands

Stands harvested from 1990 to 2002 that have been artificially regenerated, including spruce, spruce/pine and pine stands, are considered existing managed stands. They will be grown on managed stand yield curves produced using the MOF table interpolation program for stand yields (TIPSY) growth and yield model. It is assumed these stands will be actively managed through artificial regeneration, maintenance of stocking, and management of brush competition and control of crop tree density. Regeneration assumptions for existing managed stands are shown in Table 81.

For managed stands, the average free growing target density is approximately 1,300 stems/ha (ranges from 1,200 to 1,400 stems/ha) based on operational information provided by the DFAM group supported by ISIS data. It is assumed that the planting densities of 1,400 stems/ha are implemented to achieve target free growing densities of 1,300 stems/ha because planting survival is less than 100% and ingress of crop trees is felt to be minimal. Ten percent of pure pine stands will regenerate naturally to their initial natural (VDYP) yield curves. These stands will be identified randomly within the timber supply model.

The DFAM group and Fort Nelson Forest District staff consider a regeneration delay of 2 years to be a conservative assumption, given the variability of the regeneration delay between 1990 and 2002[37]. The younger existing managed stands have a lower regeneration delay to reflect current management of prompt regeneration while some of the older existing managed stands have a regeneration delay greater than 2 years.

Table 81: Existing managed stand regeneration rules

Primary Analysis Units	Leading species	Regeneration delay (years)	OAF 1	OAF 2	Regeneration method		Species		Planting Density
					Type	%	Code	%	Stems/ha
01	Spruce	2	15	5	Planted	100	Spruce	100	1,400
02	Spruce/pine	2	15	5	Planted	100	Spruce	100	1,400
06	Pine*	2	15	5	Planted	90	Pine	90	1,400
		4	15	5	Natural	10	Pine		

*10% of the pure pine stands will be regenerated naturally using the unmanaged yield curves.

16.1.2.2 Current and future managed stands

Current managed stands represent those areas within the TSA that have been harvested and planted after 2002. They exhibit similar regeneration rules to existing managed stands except for a change in the regeneration delay (Table 82). A regeneration delay of 1 year for current future managed stands is assumed to be reasonable given current performance, which the DFAM group and the Fort Nelson Forest District affirm to be approaching 0. These regeneration assumptions will also apply to future managed stands. Survival and ingress on future managed stands is assumed to be similar to current managed stands. Current and future managed stands will be grown with a genetic gain assumption of 3% for pine as described in Section 16.3.

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[37] The effective regeneration delay of 2 years between the period 1990-2002 has been confirmed through an assessment of ISIS (using a query of Disturbance_Date – Planted_Date + Plant Stock Age).

Table 82: Current and future managed stand regeneration rules

Primary Analysis Units	Leading species	Regeneration delay (years)	OAF 1	OAF 2	Regeneration method		Species		Planting Density
					Type	%	Code	%	Stems/ha
01	Spruce	1	15	5	Planted	100	Spruce	100	1,400
02	Spruce/pine	1	15	5	Planted	100	Spruce	100	1,400
06	Pine*	1	15	5	Planted	90	Pine	90	1,400
		4	15	5	Natural	10	Pine		

*10% of the pure pine stands will be regenerated naturally using the unmanaged yield curves.

16.2 Species conversion

No species conversion will be modeled in this analysis. All mixedwood stands are expected to regenerate to the same mixedwood types following harvest.

16.3 Gene resources — use of select seed

The Forest Practices Code requires the use of best available genetic seed and vegetative material for regeneration treatments within management units in BC. Specific yield adjustments that recognize the use of select seed (orchard and superior provenance seed with a known Genetic Worth) must be described for use in the base case and sensitivity analysis. This information is typically managed by seed planning unit (SPU) for genetic worth and seedlot information.

Historic use of select seed was provided by Tree Improvement Branch[38] from SeedMap (Seed Use: Report 1 – Seedlings Requested by Species and Genetic Class) summary reports and illustrates that predominately Class B seedlings have been used for most regeneration in the Fort Nelson TSA. Class B seedlings have no effective genetic gain. Class B+ seed has been used in the Fort Nelson TSA since 2000 for all planted Pine types, exhibiting a genetic worth of 3% (Table 83)[39]. This information will be used to derive the appropriate genetic gain estimates for current/future managed pine stands in the Fort Nelson TSA. All other existing and future managed stands will be modelled with no genetic gains in the base case.

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[38] personal communication and correspondence with Ron Planden (Tree Improvement Branch)

[39] Since the completion of the data package, it was found that the 3% genetic gain pine seedlings can only be planted where elevation is between 210 and 710 metres.

Table 83: Historical use of seed source in the Fort Nelson TSA

Year	Seed Planning Zone	Class B Seedlings Requested	Class B+ Seedlings Requested	Actual Genetic Worth (%)
2004	SX	1,100,000		
2003	AT	50,000		
	PLI	0	160,000	3
	SX	7,215,000		
2002	AT	30,000		
	EP	15,000		
	PLI	0	280,000	3
	SX	5,656,000		
2001	LARIDEC	2,000		
	LS	2,000		
	LT	2,000		
	PLI	2,000	252,000	3
	SX	5,382,000		
2000	AT	15,000		
	EP	15,000		
	PLI	226,000		
	SX	3,807,500		

Further SeedMap summary reports were provided by the Tree Improvement Branch (Species Plans: Report 1 – Species Plan Timeline) which identified that Class A Spruce seeds will be available in the future for the seed planning unit: SX PR MID and SX PR LOW (Table 84). This Class A Spruce seed and the associated genetic gain will be modelled for future stands as a sensitivity analysis but not included in the base case analysis. Two sensitivity analyses are proposed: a calculated 1% net genetic gain which will be applied to all spruce future managed yield curves which assumes that only 4.7% of the spruce seed required in the Fort Nelson TSA will be Class A. A second sensitivity analysis will apply a 20% average genetic gain to all future managed spruce stands which assumes that all spruce seed requirements for the Fort Nelson TSA will be fulfilled by Class A seed (Table 84). The yield curves will be adjusted for genetic gain using the TIPSY genetic gain function.

Table 84: Future genetic worth by SPU and year with calculated net genetic gain

SPU	Min./Max. Elevation	Time Period for Seed Availability	Total Class A Production for SPU during time period	Future Genetic Worth	Average Class A Requests for Fort Nelson TSA %	% of Class A of Total Seedlings Planted in TSA (a)	Weighted Average Genetic Gain (b)	Net Genetic Gain (a x b)
SX PR LOW	1/650	2006-2008	6,100,000	17	~ 9.3*	4.74**	20	1 %
SX PR MID	650/1200	2004-2012	19,100,000	21				

* average class A requests for Fort Nelson TSA provided by Ron Planden (Tree Improvement Branch)

** calculated based on average Class A planted of total seedling requirements

16.4 Backlog and current not satisfactorily restocked areas

Not satisfactorily restocked (NSR) areas were identified by using the data from the VRI, forest development plans (FDPs) and the depletions coverage[40]. There are currently 100,382 ha of NSR in the Crown forested land base, of which only 10,962 ha would contribute to the THLB (Table 85). As described earlier in Section 13.4.2, NSR areas that are non-productive, misclassified or from wildfires, and without a history of management are taken out of the THLB, as shown in Table 85. NSR areas are considered part of the THLB if the land has been identified as previously logged or managed with silvicultural activities in VRI or in FDPs.

Table 85: Backlog and current not satisfactorily restocked stands

NSR Type	History of Management	Area in inventory file (ha)	CFLB (ha)	THLB (ha)
Current	yes	10,852	9,800	8,095
Backlog	yes	2,139	1,994	1,704
Backlog	no	208	198	0
No Date	yes	3,627	3,296	1,162
No Date	no	85,898	85,094	0
NSR from wildfire, NP, or misclassified		**86,106**	**85,292**	**0**
NSR requiring regeneration		**16,618**	**15,090**	**10,962**
Total		**102,723**	**100,382**	**10,962**

NSR areas in the THLB will be regenerated (naturally or artificially) and are shown by Analysis Units in Table 86. It is expected that all current NSR will be regenerated according to current management assumptions, whereby AU 1, 2, and 6 will be modelled using TIPSY curves and the remainder of the AUs will be managed on natural growth and yield curves using VDYP. Based on a review by the Fort Nelson Forest District and the DFAM group, stands of backlog NSR and NSR with no known establishment date are expected to regenerate naturally and contribute to timber harvesting in the future. Both of these conditions will receive a regeneration delay of 10 years to account for the uncertainty associated with natural regeneration in these areas.

Table 86: Area (ha) in NSR that contributes to the THLB by analysis unit

Analysis Unit #	Analysis Unit	No year	Backlog NSR	Current NSR	Total NSR
1	Spruce	301	23	2,809	3,133
2	Spruce/ pine	38		17	54
3	Spruce/deciduous	295	66	854	1,214
4	Aspen/ coniferous	123	3	935	1,060
5	Aspen/ deciduous	246	1	2,467	2,714
6	Pine	92	1,608	852	2,552
7	Pine/ deciduous	9		43	52
8	Cottonwood/ coniferous	26	1	32	59
9	Cottonwood/ deciduous	34	2	86	122
10	Spruce/ larch	0		1	1

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[40] The Depletion coverage contains information from ISIS (Integrated Silviculture Information System)

11	Subalpine fir	0			0
12	Birch	0	0	0	0
Total		**1,162**	**1,704**	**8,095**	**10,962**

17 Unsalvaged Losses

Unsalvaged losses are reductions in harvest volume due to epidemic insect, fire and wind catastrophes. These losses are necessary since only the smaller endemic events are captured by the forest cover inventory and yield curve assumptions.

A summary of all the unsalvaged losses for the Fort Nelson TSA is provided in Table 87. Explanations of the assumptions are provided in Sections 17.1 to 17.3.

Canfor provided salvage data in their operating area for the 1990-2003 period. On average, 595 m^3/ha were salvaged from insects and disease during the last 13 years. No salvage data was provided by BCTS so it was assumed that they had similar salvaged totals as Canfor. The total annual salvaged volume for insects and disease is assumed to be 1,190 m^3/year.

Table 87: Unsalvaged losses

Disturbance Event	Volume loss (m^3/year)		
	Gross	**Salvage**	**Net**
Spruce budworm	52,852	1,190	52,008
Spruce beetle	346		
Fire	112,520	58,173	54,347
Total	**165,718**	**59,363**	**106,355**

The gross losses associated with spruce budworm are higher than those estimated in TSR 2 (52,852 m^3/year – 31,543 m^3/year = 21,309 m^3/year). New information provided by FIDS mapping has identified a much larger area that would be susceptible to spruce budworm than estimated in TSR 2.

17.1 Spruce budworm

Spruce budworm is currently the dominant natural disturbance agent in the Fort Nelson TSA. A methodology to account for the volume losses due to budworm damage has been reviewed and accepted by Rene Alfaro at the CFS, and Bob Hodgkinson at the MOF Northern Interior Regional office.

A summary of the methodology is provided below:

1. Areas that are susceptible to budworm in the THLB were identified by stands that contain spruce or white spruce and areas of historic budworm infestations. The total area that is considered susceptible is: 3,118,572 ha.
2. From analyzing historic budworm data between 1988 and 2000, and assuming that historic infestation occurred within the susceptible area (as defined in step 1), it was found that on average 7.75% and 3.5% of the area were under a moderate and severe infestation respectively, during an outbreak period. Given the above percentage in

moderate and severe infestation and the area of susceptible stands, the area of severe susceptible stands is 109,150 ha and the area of moderate susceptible stands is 241,689 ha.

3. To represent potential volume loss, the area-weighted average volume for the susceptible stands was found to be 115.77 m^3/ha.
4. It was assumed that the duration of attack is 13 years.
   It was also assumed that stand mortality was 16% for moderate and 32% for severe stands[41].
5. Annual unsalvaged mortality during an outbreak = area susceptible to budworm (ha) * stand volume loss/ha ÷ duration of attack (years) * stand mortality.

   Annual unsalvaged mortality (severe) during an outbreak = 311,047 m^3/year
   Annual unsalvaged mortality (moderate) during an outbreak = 344,373 m^3/year

   Total for the entire TSA during an outbreak[42]: 655,420 m^3/year

6. Assume outbreak duration is 13 years and 37 years between outbreaks[43]. Assume there are no losses between outbreaks. Therefore, the "period of analysis", or the time between which an outbreak begins and ends and the second outbreak is about to begin, is about 50 years.

   Therefore, to quantify the annual unsalvaged losses due to spruce budworm during our "period of analysis" (*i.e.* when there are outbreaks and when there are no outbreaks):

   Annual unsalvaged mortality during the period of analysis = (Annual loss for the TSA during outbreaks * the duration of attack)/ period of analysis.

   Annual unsalvaged mortality during the period of analysis = (655,420 m^3/year *13 years)/ 50 years = 170,409 m^3/year.

7. Determine unsalvaged volume that is associated with the THLB. Of the 3,118,572 ha of susceptible stands, 980,691 ha (31%) are within the THLB. Therefore, the unsalvaged volume loss within the THLB is 52,852 m^3/year (170,490 m^3/year * 0.31).

17.2 Spruce beetle

Spruce beetles are known to target and attack large diameter, mature spruce (Engelmann, white, Sitka and, sometimes black spruce) when populations reach epidemic levels.[44]

Since no new data was available for spruce beetle losses in the Fort Nelson TSA, a methodology similar to that of TSR 2 was used.

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[41] Assumption provided by Rene Alfaro, Research Scientist, Canadian Forest Service.

[42] This represents total mortality loss (i.e. tree is dead) and not growth losses.

[43] Assumption provided by Rene Alfaro, Research Scientist, Canadian Forest Service.

[44] Source: Field Guide to Forest Damage in British Columbia

The volume losses from spruce beetle are estimated to be 95 205 m^3 over the attack cycle from 1947 to 1994, resulting in an annual loss of 2,026 m^3/year (95 205 m^3/47 years)[45]. The calculated unsalvaged loss for spruce beetle on the THLB would equal to 346 m^3/year:

= annual loss * (spruce leading area on THLB/ spruce leading area in forested land)
= 2 026 m^3/year * (463,460 ha/2,715,448 ha)
= 346 m^3/year

17.3 Fire

A similar assumption to TSR 2 will be used to account for unsalvaged losses due to fire. No complete fire data since TSR 2 was available at the time of the data package. Therefore, the methodology applied in TSR 2 was felt to be the best available information.

Unsalvaged losses due to extreme fire events on the timber harvesting land base are calculated as follows:

Total annual losses * (timber harvesting land base/total forested land base[46])

Annual losses on timber harvesting land base from fire = 451 000 m^3/year * (1,432,269 ha /5,740,812 ha) = 112,520 m^3/year. The majority of the unsalvaged loss (95%) would be attributed to coniferous stands and the remainder from deciduous (5%).[47]

Since current salvage numbers for the TSA were not available for the entire TSA it is assumed that, similar to TSR 2, approximately 58,173 m^3 were salvaged annually from fires.

Salvage from fires varies annually in the Fort Nelson TSA and historically there have been two significant salvage programs dominated by two large fires in 1985 and 1996. Similar to TSR 2, the total volume salvaged (698,077 m^3) for these events are averaged over the 12-year period equaling 58,173 m^3/year.

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[45] *Forest Susceptibility to Spruce Budworm Defoliation in the Forest Nelson Area of British Columbia*, J.S. Clowater.

[46] Total forested land base is defined as BCLCS_LVL1=V (vegetated) and is not defined by NP_Descriptor as a wetland, river, lake or non-productive.

[47] Based on Fire Unsalvaged Losses from Fort Nelson Timber Supply Area - Analysis Report (MOF), March 2000

18 Resource Management Emphasis

This section provides details on how the modeling methodology will integrate non-timber resource values with timber objectives, which is often done through forest cover requirements. Forest cover management aims to maintain biodiversity, wildlife habitat, domestic water use, and visual quality by specifying target height or age distributions. The zones that have been identified can overlap, which requires the model to account for the rules as they apply to each specific zone.

The primary source of direction for forest cover management in the Fort Nelson TSA is the approved *Fort Nelson Land and Resource Management Plan (1997)*, which includes the Muskwa-Kechika Management Area Plan. Table 88 provides a summary of forest cover rules for the Fort Nelson TSA.

Table 88: Forest cover rules for the Fort Nelson TSA

Resource Emphasis Zone[a]	Total Crown forest area (ha)	Timber harvesting land base (ha)	Maximum allowable disturbance (%)	Minimum height for disturbance (meters)	Applies to:
Established Preservation VQO	1,755	264	0 – 1 (average 0.47%)	Varies by VQO polygon[b]	
Established Retention VQO	24,872	5,940	2-4 (average 2.8%)		CFLB
Established Partial retention VQO	63,055	17,045	7-13 (average 9.6%)		CFLB
Established Modification VQO	89,135	31,826	17-23 (average 19.6%)		CFLB
Established Maximum modification VQO	11,678	4,334	29 – 36 (average 33.1%)		CFLB
Recommended Retention VQO	9,771	1,226	3.05	Varies by VQO polygon[b]	CFLB
Recommended Partial retention VQO	371,757	102,200	10.05		CFLB
Recommended Modification VQO	26,547	9,527	20.05		CFLB
Recommended Maximum modification VQO	5,123	2,642	32.55		CFLB
Enhanced resource development zone[c]	2,090,155	613,027	39	3 m	THLB
General resource development zone[c]	1,899,556	591,633	39	3 m	THLB
Muskwa-Kechika management zone[c]	1,751,501	227,609	39	3 m	THLB

[a] The maximum allowable disturbance and the minimum height for disturbance will vary depending on VQO and VAC – see Section 18.2.

[b] Each polygon within a zone or group will be modeled individually (i.e. unique VQO or special management zone).

[c] Enhanced resource development, general resource development and Muskwa-Kechika special management will be modeled by landscape unit. The maximum allowable disturbance assumption is taken from TSR 2.

All productive forest, whether it is considered part of the timber harvesting land base or not, is tracked and is considered to contribute towards maintaining the forest cover mature plus old and old-seral stage, and visual quality objectives (VQO) requirements.

Only the productive forest within the timber harvesting land base is tracked and is considered to contribute towards maintaining the forest cover adjacency requirements within the enhanced, general and special management zones.

18.1 Adjacency cutblock green-up

The forest cover rules for enhanced, general resource development and special management zones provided in Table 88 approximate the operational block adjacency rules for the Fort Nelson TSA. Operationally, adjacency requires a logged block to reach a certain height target (green-up) before a neighbouring area can be harvested. Based on direction provided in *the Landscape Unit Planning Guide 1999* and by the Fort Nelson Forest District, licensees are able to alter adjacency rules to achieve target patch sizes. It is understood that this is current management in the Fort Nelson TSA. No specific patch size targets will be modelled in the base case and adjacency green-up will be modelled using forest cover rules for each management zone.

18.2 Visual resources

The broad Visual Landscape Inventory was made known in 1997, which identifies the visual sensitivity ratings and the recommended visual quality classes (RVQCs) for all visually sensitive conditions. A partial update of this broad mapping was completed in 2002 to reflect the Cassiar addition to the district land base. Also released in 1997 were detailed visual landscape inventories for the Alaska Highway and Klua Lakes[48], for which visual quality objectives (VQOs) were established. The visual quality modelling for the Fort Nelson TSA will follow closely the recommendations outlined in *Procedures for Factoring Visual Resources into Timber Supply Analyses* (the *Procedures*).

Polygons with established VQOs also contain a visual absorption capacity (VAC) rating in the visual landscape inventory. There are an additional 413,198 ha of area with recommended visual quality classes (RVQCs) in the CFLB. The visually effective green-up (VEG) height will be determined separately for each visual quality polygon based on slope. The VEG height ranges from 3 to 8.5 metres with the TSA average being 3.8m.

18.2.1 Established Visual Quality Objectives

To achieve the VQOs, a percent denudation is usually modelled. Percent denudation is the permissible alteration in plan view, and it refers to the proportion of a visual polygon that can be less than the visually effective green-up (VEG) height. The VEG height will be determined for each VQO polygon based on slope (Table 6 in the *Procedures*). A range of percent denudation is provided for each VQO category based on the *Procedures:* the percent to be applied in the Fort Nelson TSA will be modified by the visual absorption capability (VAC[49]), whereby the low, medium and high VAC will correspond to the mid-point of the lower third, middle, and upper third of the percent denudation range (Table 89). For example, a polygon with VQO retention and a low VAC will have a 2.07% of allowable alteration. The percentages provided in the table will be rounded off for application in the timber supply model.

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[48] The Klua watershed has been established as a protected area after it was designated as an established VQO area. Therefore, the Klua Lake protected area is removed from the THLB and no undue impact is created by the VQOs per se.

Table 89: Range of allowable percent alteration

VQO Category	% Denudation Range[1]	Low VAC	Medium VAC	High VAC
Preservation	0 – 1	0.25	0.5	0.75
Retention	1.1 – 5	2.07	3.05	4.02
Partial Retention	5.1 – 15	7.57	10.05	12.52
Modification	15.1 – 25	17.57	20.05	22.52
Maximum Modification	25.1 – 40	28.82	32.55	36.27

[1] The lower limit of the denudation range will be applied in a sensitivity analysis.

18.2.2 Recommended Visual Quality Classes

The DFAM group currently tries to manage within the RVQCs to achieve the visual management objectives. The majority of the RVQCs occur within the river corridors where operations have been absent recently due to conflicting objectives between patch size objectives and severe Spruce budworm infestation.

Therefore, it is proposed that the RVQCs be included in the base case as reflective of current management. The RVQCs will be modelled following the guidelines in the *Procedures for Factoring Visual Resources into Timber Supply Analyses* (1998). Since no visual absorption capability (VAC) ratings are available, the RVQCs will be modelled based on Table 3 from the *Procedures*. Also, without a full visual landscape inventory and analysis, it is recommended that the mid-point of each RVQC percent denudation range be used, as illustrated in Table 90. Two other sensitivities are proposed to test the minimum allowable disturbance (Sensitivity 1) and maximum allowable disturbance (Sensitivity 2).

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[49] Visual absorption capability is a component of the visual landscape inventory that rates the relative capacity of a landscape to absorb visual alterations and still maintain its visual integrity. The VAC is based on an estimate of physical characteristics, including slope, vegetation pattern diversity, soil/vegetation color contrast and aspect.

Table 90: Proposed forest cover requirements for RVQC

RVQC	% Denudation Range	Base Case %	Sensitivity 1 %	Sensitivity 2 %
Preservation	0 - 1	0	0	1
Retention	1.1 - 5	3	1	5
Partial Retention	5.1 - 15	10	5	15
Modification	15.1 - 25	20	15	25
Maximum Modification	25.1 - 40	33	25	40

18.3 Recreation resources

Recreation resources are of high value in the Fort Nelson TSA. As such, specific reductions associated with recreation have been applied across all biogeoclimatic zones throughout the management unit. Refer to Section 13.4.6 for these "Environmentally Sensitive Areas" that have been accounted for in the netdown.

18.4 Wildlife

18.4.1 Wildlife habitat — identified wildlife

There is significant wildlife presence within the Fort Nelson TSA, as well as numerous species that are threatened or are of concern. It is understood that those red and blue listed species (Table 91) are affected by forest and range practices and may require detailed habitat management prescriptions to sustain regional populations.[50]

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[50] Information provide by email communication Joelle Scheck, RP Bio, Ecosystem Biologist with the Ministry of Water, Land and Air Protection

Table 91: Table of Red and Blue listed species in the Fort Nelson TSA.

Endangered or Threatened (Red-listed)		Vulnerable (Blue-listed)	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**
Martes pennanti	Fisher	*Botaurus lentiginosus*	American Bittern
Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow	*Grus canadensis*	Sandhill Crane
Bison bison athabascae	Wood Bison	*Salvelinus confluentus*	Bull Trout
Coregonus artedi	Cisco	*Ursus arctos*	Grizzly Bear
Coregonus autumnalis	Arctic Cisco	*Asio flammeus*	Short-eared Owl
Dendroica castanea	Bay-breasted Warbler	*Dendroica virens*	Black-throated Green Warbler
Dendroica tigrina	Cape May Warbler	*Gulo gulo luscus*	Wolverine, *luscus* subspecies
Notropis atherinoides	Emerald Shiner	*Hiodon alosoides*	Goldeye
Notropis hudsonius	Spottail Shiner	*Melanitta perspicillata*	Surf Scoter
Oporornis agilis	Connecticut Warbler	*Myotis septentrionalis*	Northern Long-eared Myotis
Pungitius pungitius	Ninespine Stickleback	*Rangifer tarandus* pop. 14	Caribou (boreal population)
		Rangifer tarandus pop. 15	Caribou (northern mountain population)
		Salvelinus malma	Dolly Varden
		Stenodus leucichthys	Inconnu
		Vireo philadelphicus	Philadelphia Vireo
		Wilsonia canadensis	Canada Warbler

It is also understood that currently MWLAP is producing a list of Regionally Important Wildlife for the Peace Region which will include: arctic grayling, lake trout, walleye, mountain goat, Stone's sheep, trumpeter swan, northern goshawk, and the American bittern. The MWLAP feels these species will require measures above and beyond what is currently in place for forest and range practices (*e.g.* riparian buffers, WTPs, etc.). The strategies for Regionally Important Wildlife for the Peace Region will be developed once MWLAP's Deputy Minister has approved the list.

Also, there are procedures underway to develop ungulate winter range (UWR) in the Fort Nelson TSA. The MWLAP's priorities to complete this work are provided in Table 92. The priorities for the Identified Wildlife Management Strategy (IWMS) are also provided.

Table 92: List of MWLAP priorities for developing ungulate winter range and IWMS.

Species	UWR Priority	IWMS Version 2 Priority
Northern and boreal caribou	High	High
Stone's sheep	Medium - High	
Elk	Medium - High	
Mountain Goat	Medium - High	
Wood Bison	Medium	
Moose	Low	
Mule deer	Low	
Bull trout		High
Fisher		Medium
Wolverine		Medium
Sandhill crane		Medium
Bay-breasted warbler		Medium
Cape May warbler		Medium
Connecticut warbler		Medium
Black-throated green warbler		Low
Nelson's sharp-tailed sparrow		Low
Grizzly bear		Low
Short-eared owl		Low

The provincial IWMS provides direction, policy, procedures, and standardsfor managing Identified Wildlife on Crown forest and range land. The objectives are to mnimize the effects of forest and range practices on Identified Wildlife and to maintain their critical habitats throughout their current and, where appropriate, historic ranges. Identified Wildlife are managed through the establishment of wildlife habitat areas (WHAs) and the implementation of general wildlife measures (GWMs), or through other management practices specified in straegic or landscape level plans. [51]Currently, there are no WHA or GWMs established within theFort Nelson TSA but where identified wildlife have been sighted on a management unit, licensee are managing these areas as outlined in the *Managing Identified Wildlife: Procedures and Measures. Volume 1. Feb. 1999.*

18.4.2 Caribou winter habitat

The caribou populations found within the Fort Nelson TSA are currently feerally listed as Vulnerable or Not at Risk[52]. Caribou winter habitat area in the western portn of the Fort Nelson TSA has been identified but currently there are no developed management jans or strategies: they will be developed after plans are complete for Endangered and Threatoed population elsewhere in the province. There are also recovery strategies being developd for specific boreal caribou populations in the central/eastern portion of the district, which are not expected to cause an impact on future timber supply[53]. Since forest management practices for caribou winter habitat have not been formally established in the TSA, no net reductions to the THLB or forest cover requirements are necessary.

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[51] from: http://wlapwww.gov.bc.ca/wld/identified/index.htm

[52] Information provided by email communication Joelle Scheck, RP Bio, Ecosystem Biologist with the Ministry of Water, Land and Air Protection

18.5 Biodiversity

18.5.1 Landscape-level biodiversity

18.5.1.1 Policy framework

The *Landscape Unit Planning Guide* provides direction regarding the establishment of old seral cover and wildlife tree retention as the current priorities for landscape and stand level biodiversity management in BC. Objectives for coarse woody debris and patch size distribution will not be modeled in the base case.

18.5.1.2 Landscape units

The Fort Nelson TSA contains 85 landscape units (LU) that have been established by the Chief Forester but the biodiversity emphasis options remain draft. Of the 85 LUs, there are 4 high, 45 intermediate and 36 low emphasis units. Current management is to follow the biodiversity emphasis options within the TSA.

18.5.1.3 Biodiversity emphasis options and forest cover requirements

Mature and old and old forest seral rules will be applied in the base case following the specific BEO that applies to each landscape unit (Appendix 7). The recommended seral stage distribution for each BEC unit/NDT (% of forest area within the landscape unit) is shown in Table 93.

Table 93: Recommended seral stage distribution for each biogeoclimatic unit and natural disturbance type combination

BEC unit	NDT	Biodiversity Emphasis Option								
		LOW			INTERMEDIATE			HIGH		
		early	*mature+ old*	*old**	*early*	*mature+ old*	*old*	*early*	*mature+ old*	*old*
SWB	2	n/a	n/a	>9	n/a	n/a	>9	n/a	n/a	>13
BWBS-conifer	3	n/a	>11	>11	n/a	>23	>11	n/a	>34	>16
BWBS-deciduous	3	n/a	>13	>13	n/a	>23	>13	n/a	>34	>19

* in the low emphasis units old seral can be modeled using 1/3 of the target for the first 70 years, 2/3 of the target in 140 years and the full old target by 210 years and beyond.

In the analysis, old seral targets will be applied at the BEC variant level as referenced in Tables A2.8 and A2.13 of the *Landscape Unit Planning Guide*. In low emphasis landscape units, the full old target can be achieved over 3 rotations by using a recruitment strategy. Mature + old seral targets would also be applied to NDT3 (*Landscape Unit Planning Guide)*. The age definitions that will be used in the analysis are defined in Table 94.

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[53] Telephone correspondence with Rod Backmeyer, Wildlife Biologist, Fish and Wildlife Science And Allocation Section, in the Ministry of Water, Land and Air Protection. March 2, 2004.

Table 94: Seral stage definitions by biogeoclimatic unit and natural disturbance type

BEC unit	NDT	Mature Seral	Old Seral
SWB	2	> 120	>250
BWBS-conifer	3	>100	>140
BWBS-deciduous	3	> 80	>100

18.6 Domestic Water Resources

One of the main objectives of the LRMP is to minimize man-made changes to stream configurations by managing resource development adjacent to sensitive water bodies, lakes, wetlands, rivers and streams to minimize negative impacts to water quality and quantity.

The water resources within the Fort Nelson TSA include the Arctic watershed. The plan area is drained by the Liard River and its major tributaries: the Fort Nelson, Prophet, Muskwa Toad, Petitot and Kechika rivers. A minor portion of the area near the Alberta border is drained by the Hay River, which flows toward the Mackenzie River. The town of Fort Nelson and Fort Nelson Indian Band draw their water supply from the Muskwa River. The community at Prophet River and the Indian Band draw water from Adsett Creek, and the community of Toad River draws its water from the Toad River. Groundwater reserves are scarce and are used sparingly.

There are no known Forest Practices Code designated community watersheds within the Fort Nelson TSA; however, there are 20 sources of domestic water intakes or points of diversion (POD) in the Fort Nelson TSA. These points represent domestic water licenses issued by the Ministry of Sustainable Resource Management under the *Water Act*. Recognizing these areas as a "forest resource", the Forest Practices Code specifies sufficient management and conservation of these values during operational forest activities and planning.

Each POD has been given a buffer width of 100 m to recognize the special consideration to maintain water resources (Table 95). No harvest is planned within these areas.

Table 95: Domestic water licence intakes

Name	Total area (ha)	Crown forested land base area (ha)	Timber harvesting land base area (ha)	Maximum % Disturbance
All domestic water intakes	48	36	16	0%

19 Timber harvesting

19.1 Minimum harvestable age

The minimum harvestable age (MHA) is an estimate of when immature or future managed stands will become available for harvest. It is not expected that all stands will be harvested at this age but harvesting may occur at the MHA to meet a harvest target for a relatively short period of time or to avoid large and abrupt changes in harvest levels. Within some areas, stands may not be harvested until they are much older than the minimum harvestable age due to extended rotations for forest cover requirements such as landscape biodiversity old forest objectives.

Based on discussions with the DFAM group, the minimum harvest criterion for the Fort Nelson TSA is 140 m^3/ha for natural stands. The resulting minimum harvest age will be compared with the age at which 95% of the maximum MAI is realized which will be tested in a sensitivity analysis. The minimum harvestable age was determined for each analysis unit/yield curve groups and is provided in Appendix 8. Polygons within the analysis unit/yield curve groups will be considered eligible for harvest within the timber supply model when they achieve the minimum criteria described above.

19.2 Harvest systems

Harvesting in the Fort Nelson TSA is dominated by conventional ground-based systems. There is some operable cable and helicopter ground around the Muskwa-Kechika special management area, but these systems are not being used at this time.

19.3 Initial harvest rate

The initial harvest rate for the base case analysis will be set to 1,605,855 m^3/year (the current AAC of 1,500,000 m^3/year plus the calculated unsalvaged losses minus 500m^3/year for woodlot W1817). There may be a need to increase or decrease the harvest level from this starting point but this will not be determined until the base case analysis is initiated. If such a change is required it will be discussed with the DFAM group and Forest Analysis Branch.

19.4 Harvest rules

Harvest rules define current management for the analyst to use in the forest level model. This will be accomplished by following the spatial forest development plan. By including the FDP, the approved and proposed blocks can be established as a fixed harvest schedule for the initial period. Following the FDP, priority harvest can be dictated by an established harvest rule. Relative oldest first will be used, as this rule best represents harvest priority within the TSA. It is also proposed that different harvest rules will be tested to determine the effect on the harvest level.

19.5 Disturbing the non-timber harvesting land base

To prevent the contributing, non-timber harvesting land base from continually aging and providing a disproportionate and often improbable amount of old forest cover conditions to satisfy landscape biodiversity requirements, a disturbance function must be applied.

The document *Modeling Options for Disturbance Outside the THLB – Working Paper* provides direction for disturbing areas of the landscape outside of the THLB. There are a variety of possible approaches to applying a disturbance in the contributing non-timber harvesting land base. While each approach has its strengths and weaknesses there remains a significant amount of uncertainty as to what the most appropriate methodology would be.

The age reset by variant for the contributing, non-timber harvesting land base methodology is proposed for the base case analysis. The methodology (*Modeling Options for Disturbance Outside the THLB – Working Paper*) is as follows (Table 96):

1. List the estimated return interval for disturbance in each variant and NDT in the TSA (*Landscape Unit Planning Guide Appendix 2*).
2. Establish the age of old and estimated minimum target % of old seral that would be expected (*Landscape Unit Planning Guide Appendix 2*). The % old target is weighted by the CFLB area corresponding to the % old target by BEO.
3. Calculate a rotation age based on the age distribution described in step 2 (target age/(1-target %).

This analysis was completed on the BEC unit since the variants and NDTs represent the same groupings. In each BEC unit, when an area in the non-harvesting land base reaches the effective rotation age, as shown in Table 96, a 'disturbance' is modeled and the area is set back to age 0 and goes through succession again. The amount of area that is disturbed in the non-harvesting land base over time is shown in Figure 44.

Table 96: Minimum target area to be disturbed annually in each BEC variant

		a	b	c	d	e
BEC unit	**NDT**	***Return Interval***	***Min. Target % Old***	***Age of Old***	***Effective Rotation Age***	***Contributing Non-THLB***
		LUPG	*LUPG*	*LUPG*	(c/(1-b))	
Spruce Wllow Birch (SVB)	2	200	11	250	280	1,032,669
Boreal Wite and Black Spuce (BWBS)-onifer	3	100	13	140	161	2,339,890
Boreal Wite and Black Spuce (BWBS)-deciduous	3	125	16	100	119	795,096
Total:						4,167,656*

* Total doenot sum up to total reductions because some areas had missing info and could not be classified into a BEC unit (missing spcies, etc.)

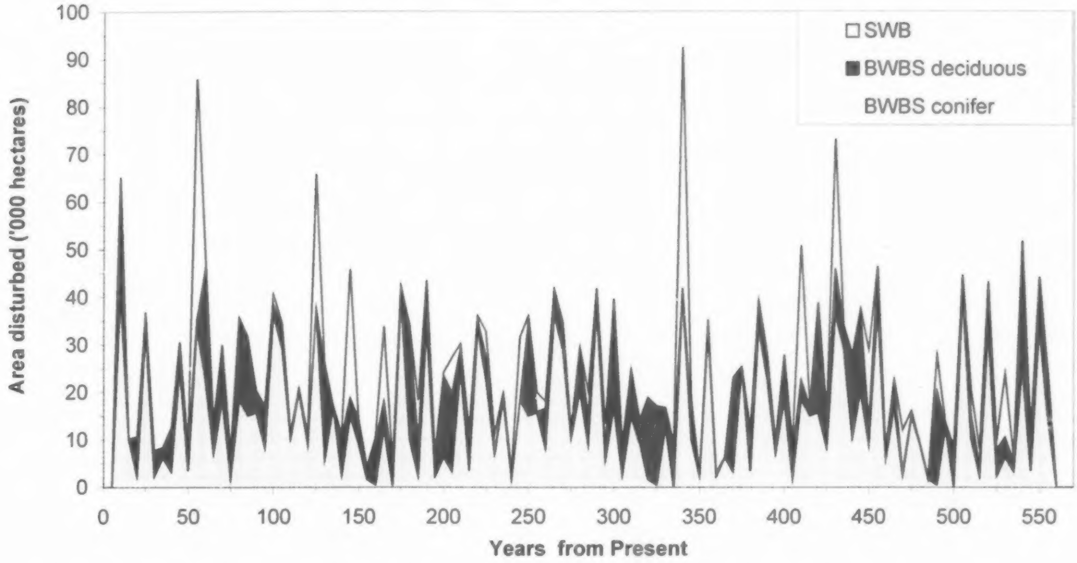

Figure 44: Area disturbed in the non-harvesting forested land base over time by biogeoclimatic zones

19.6 Timber supply model

The model that will be used for this analysis will be:

Model Name: FSOS
Model Developer: Dr. Guoliang Liu
Model Development: UBC, Hugh Hamilton Limited, Forest Ecosystem Solutions Ltd.
Model Type: Forest and Landscape, Spatial/Non-spatial, Simulation and Optimization Model

FSOS has been used on over 24 management units (TFLs and TSAs) from small (<15,000 ha) to very large (> 4 million ha) forest areas throughout BC, Alberta, Manitoba and Ontario. Some of the management units that FSOS have been applied include: TFL 3, TFL 18, TFL 26, TFL 37, TFL 53, Soo TSA, Sunshine Coast TSA, Queen Charlotte TSA, Kingcome TSA and Kalum TSA. FSOS has been accepted for use in timber supply analysis by the chief forester in British Columbia and is currently being applied to 3 management units in Ontario.

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Appendix 5: Stream Riparian Classification Methodology

Studies were available that allowed for the development of relationships between stream order and stream classes, and though limited in scope, this method provided an immediate opportunity to assign stream classes to stream features based on stream order and statistics. TRIM I stream features were GIS processed, using a custom Arc/Info AML, to determine a (simplified) stream order attribute that was appended to the Arc/Info Arc Attribute Table.

Having determined stream order, the following assumptions were made (Table 97 and Table 98):

1) Streams assigned to stream orders 3 and higher correspond to stream classes 1 to 4 (Table 97) while stream order 1 and 2 correspond to stream classes 5 and 6 (Table 98). This relationship was found in a watershed study done in the Fort Nelson TSA (Lower Dunedin Landscape Unit) and also from information provided by MSRM in Prince George. Using GIS utilities, the total lengths of streams were summed for the two stream order classes (*i.e.* 73, 841 km for S1-S4 and 194,105 km for S5-S6).
2) The percentages of each stream class within the two stream order classes (column A in Tables) were determined from a GIS analysis for TSR 3 (using the Lower Dunedin study) and from data in the Kamloops TSA.
3) The lengths of streams in each stream class were determined by multiplying the total length of the stream order class (determined in step 1) with the percentages in step 2 (Column B). e.g. for S4, 73,841km X 0.20 = 14, 768 km.
4) Each stream class was assumed to have a combined riparian buffer width (RZ and RMZ) as suggested by the *Riparian Management Area Guidebook* (Table 99). The combined riparian width is also shown in Column C in the Tables.
5) The Riparian Management Areas (RMA) for each stream class (Column D in Tables) is calculated from the lengths and widths in Column B and C. For example, for S1, RMA = [14, 768 km X 1000 m/km X (60m X 2)] ÷ 10 000 ha/m^2 = 177, 219 ha. Note that the combined riparian buffer width (Column C) is the buffer width for one side of the stream.
6) The effective riparian width is the width that needs to be applied to the stream order class to represent the combined RMA for all the corresponding stream classes. For example, for S1-S4 (Table 97) the effective riparian buffer width is: [(494, 737 ha X 10,000 m^2/ha) ÷ (73,841 km X 1,000m/ km)] ÷ 2 = 33.5m (buffer width for one side of the stream).

Table 97: Calculations for S1 to S4 streams

	A	B	C	D	E
Estimates of breakdown for S1 to S4	**Estimated % of Stream Order 3+**	**Length (km)**	**Combined riparian buffer width (RZ and RMZ) (m)**	**RMA (ha)**	**Effective riparian buffer width (m)**
GIS Length S1 (km)	20	14,768	60	177,219	33.5
GIS Length S2 (km)	20	14,768	40	118,146	
GIS Length S3 (km)	40	29,537	30	177,219	
GIS Length S4 (km)	20	14,768	7.5	22,152	
GIS Total Length S1-S4 (km)		**73,841**		**494,737**	

Table 98: Calculations for S5 and S6 streams

	A	B	C	D	E
Estimates of breakdown for S5 and S6	**Estimated % of Stream Order 1 and 2**	**Length (km)**	**Combined riparian buffer width (RZ and RMZ) (m)**	**RMA (ha)**	**Effective riparian width (m)**
GIS Length S5 (km)	20.15	39,104	7.5	58,656	2.31
GIS Length S6 (km)	79.85	155,001	1	31,000	
GIS Total Length S5-S6 (km)		**194,105**		**89,656**	

Table 99: Riparian reserve and management zone widths

Stream Class	**Reserve zone width (metres)** 100% reduction	**Management zone width (metres)**	**Management Zone Volume Reduction (%)**	**Combined riparian buffer width (RZ and RMZ) (m)**
S1 (except large rivers)	50	20	50	60
S2	30	20	50	40
S3	20	20	50	30
S4	0	30	25	7.5
S5	0	30	25	7.5
S6	0	20	5	1

The proposed methodology was recently reviewed by MSRM, Resource Information Branch in Prince George and Victoria Service Centre[54]. The review document notes that the methodology used for the TSA presents a generalized approximation of stream classification and calculated reduction, which contains inherent risks and biases, which must be understood. The risks identified are:

1. The Lower Dunedin analysis (Poulin and Associates) results used in the riparian methodology was limited mostly to the BWBS zones, but was extrapolated to the entire TSA. In particular, data from the SWB zone, which contains major rivers and streams, was not available. It is understood that there are sport and regionally important fish species in several 2nd order sampled streams.
2. Only fish that are managed for under the Forest Practices Code were included in the analysis. Since no regionally important species are currently designated for the Peace Region, they were not included in the study. If these species are identified in the future as species at risk or regionally significant under the Forest and Range Practices Act, they will obviously change the management assumptions.
3. The adjusted percentage of 1st and 2nd order streams calculated for the Fort Nelson TSA was different than those for the Lower Dunedin. The Lower Dunedin exhibited a higher percentage, which if applied to the Fort Nelson TSA would require a higher RMA.
4. The number of reaches in the Lower Dunedin was not sampled in the same proportion as the occurrence of reaches in the watershed nor in the same proportion as the number of reaches selected by the stratified random sample design.
5. The methodology used had documented that 18% of the observation points contained stream classification data but in fact only about 10% do.
6. The assumption correlating stream class to stream order does not recognize the variation in stream class associated with different stream reaches.
7. The fish occurrence point coverage does not match to specific streams for all points and can only be used to determine fish presence on a broad scale. It cannot be used to determine absence of a specific fish species.
8. The data for the Lower Dunedin study was collected and mapped to the TRIM 1 base.

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[54] Review of stream riparian classification and reduction for Fort Nelson TSR analysis by Lynn Blouw and David Tesch received by email March 9, 2004.

Appendix 6: Yield curves

Table 100: Secondary analysis unit yield tables (m^3/hectare) for existing natural stands VRI Rolled Over (enr) using VDYP

Age (years)	Spruce			Spruce/Pine			Spruce/Deciduous			Aspen/Coniferous			Aspen/Deciduous			Pine			Pine/Deciduous			Cottonwood/Coniferous		
	011 enr	012 enr	013 enr	021 enr	022 enr	023 enr	031 enr	032 enr	033 enr	041 enr	042 enr	043 enr	051 enr	052 enr	053 enr	061 enr	062 enr	063 enr	071 enr	072 enr	073 enr	081 enr	082 enr	083 enr
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
30	0	0	0	0	0	1	0	0	0	0	3	17	0	8	36	0	1	27	0	0	14	0	4	52
40	0	0	8	0	1	23	0	0	11	12	39	74	16	45	90	0	33	83	0	18	56	4	41	125
50	0	13	66	0	6	82	0	4	55	45	84	127	45	84	144	16	74	134	10	49	101	48	90	179
60	10	64	126	1	42	144	1	33	113	80	125	176	75	123	194	44	111	179	31	82	140	88	129	222
70	41	112	179	19	87	200	19	76	166	112	163	222	104	159	241	71	145	218	56	112	175	121	161	257
80	79	155	224	57	130	249	52	117	212	140	195	257	128	188	277	96	175	253	78	138	206	150	188	284
90	113	192	262	93	169	292	83	153	252	163	222	287	148	212	307	119	202	285	100	162	233	176	211	306
100	143	225	294	128	205	330	111	184	284	184	244	311	165	232	331	141	227	315	119	183	257	198	231	324
110	171	253	321	161	237	364	137	211	311	200	262	330	178	247	349	161	250	342	137	203	279	217	248	339
120	196	277	344	193	267	393	162	235	334	213	276	343	187	257	360	181	272	367	154	220	298	234	262	352
130	218	299	364	222	294	418	184	255	352	224	286	352	192	263	366	199	292	391	170	236	315	248	274	362
140	239	318	381	248	315	437	202	273	368	233	296	362	198	270	374	212	305	406	182	246	326	261	284	371
150	257	335	397	270	334	453	219	289	382	241	304	370	204	277	381	223	316	418	191	255	334	273	293	379
160	273	349	409	289	349	466	230	299	390	245	308	373	204	277	382	231	324	426	198	260	339	276	296	380
170	288	362	420	305	361	476	240	308	397	249	311	375	204	277	382	237	329	431	202	264	342	279	298	382
180	301	374	430	318	371	484	249	316	404	252	313	377	204	278	382	240	331	432	205	265	343	281	299	383
190	313	384	438	329	379	489	257	323	409	254	315	378	204	278	382	241	331	430	205	264	342	283	301	384
200	324	393	446	341	388	496	265	329	414	256	317	380	205	278	382	244	333	432	208	266	343	285	302	385
210	334	401	452	351	396	501	272	335	418	258	319	381	205	278	383	247	336	435	210	268	344	286	303	386
220	343	409	458	361	403	506	278	340	422	260	320	382	205	278	383	251	339	438	213	270	346	288	305	387
230	351	415	463	370	409	511	283	344	425	261	322	383	205	278	383	254	342	441	215	271	348	289	306	387
240	358	421	468	379	415	515	288	348	428	263	323	384	205	278	383	256	344	443	217	273	350	291	306	388
250	365	426	471	387	420	519	293	352	431	264	324	385	205	279	383	259	347	446	219	275	351	292	307	388
260	371	431	475	394	425	522	297	355	433	266	325	385	205	279	383	261	349	449	221	276	353	293	308	389
270	376	435	477	400	429	525	301	358	435	267	326	386	205	279	383	264	351	451	223	278	355	293	308	389
280	381	438	479	406	433	528	305	361	437	268	327	386	205	279	383	266	353	454	224	279	356	294	309	389
290	385	441	481	412	436	530	308	363	438	269	328	387	205	279	383	267	355	456	226	280	357	295	309	390
300	389	444	483	417	439	532	311	366	439	269	329	387	205	279	383	269	357	458	227	282	358	296	310	390

Table 100 continued: Secondary analysis unit yield tables (m^3/hectare) for existing natural stands VRI Rolled Over (enr) using VDYP

Age (years)	Cottonwood/Deciduous			Spruce/Larch			Subalpine Fir			Birch		
	091 enr	092 enr	093 enr	101 enr	102 enr	103 enr	111 enr	112 enr	113 enr	121 enr	122 enr	123 enr
10	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0
30	0	1	39	0	0	1	0	0	4	0	3	22
40	0	28	107	0	0	65	0	9	29	1	39	73
50	29	74	158	0	7	139	2	28	69	10	78	118
60	68	116	198	8	42	204	6	54	108	28	112	158
70	103	151	230	31	77	259	19	85	147	47	142	193
80	134	180	254	61	109	305	35	110	181	65	169	222
90	161	205	274	90	138	344	47	131	211	80	192	247
100	185	226	290	118	164	376	61	150	238	95	213	270
110	205	244	303	144	187	404	74	168	262	108	232	289
120	223	259	313	168	208	427	85	184	285	121	248	305
130	238	272	322	190	225	447	97	201	308	129	258	315
140	251	283	329	210	241	463	109	217	327	133	263	319
150	263	292	335	226	253	476	120	232	345	136	268	323
160	263	292	335	239	264	485	130	247	360	139	270	325
170	264	293	336	250	272	492	140	260	374	141	272	327
180	264	293	336	259	280	498	150	273	387	142	274	329
190	264	293	336	267	286	503	159	286	398	144	275	330
200	265	293	336	274	292	508	168	297	410	145	276	331
210	265	294	336	281	297	512	176	308	421	146	278	332
220	265	294	336	287	302	516	185	319	431	147	279	333
230	266	294	336	292	306	519	193	329	442	149	280	334
240	266	294	336	297	310	522	200	339	451	150	281	334
250	266	294	336	302	313	524	208	349	461	151	282	335
260	266	294	336	306	316	526	209	350	464	151	282	335
270	266	294	337	309	319	528	211	352	467	152	283	336
280	267	295	337	312	321	529	212	353	469	153	283	336
290	267	295	337	315	323	531	214	355	472	154	284	336
300	267	295	337	318	325	532	215	356	474	154	284	337

Table 101: Secondary analysis unit yield tables (m^3/hectare) for existing natural stands VRI Phase II (en2) using VDYP

Age (years)	Spruce			Spruce/Pine			Spruce/Deciduous			Aspen/Coniferous			Aspen/Deciduous			Pine			Pine/Deciduous			Cottonwood/Coniferous		
	011 en2	012 en2	013 en2	021 en2	022 en2	023 en2	031 en2	032 en2	033 en2	041 en2	042 en2	043 en2	051 en2	052 en2	053 en2	061 en2	062 en2	063 en2	071 en2	072 en2	073 en2	081 en2	082 en2	083 en2
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
30	0	0	0	0	0	1	0	0	0	0	6	26	0	12	38	0	2	26	0	1	19	0	5	86
40	0	0	12	0	1	12	0	0	12	20	53	95	24	59	101	3	36	82	3	25	67	6	51	169
50	0	16	74	2	7	59	0	8	58	62	106	160	62	108	162	26	78	133	22	61	113	57	111	232
60	15	67	135	9	38	117	4	42	116	102	155	219	99	155	220	56	116	177	49	95	154	103	159	280
70	54	114	188	40	82	170	30	87	169	139	201	274	134	199	273	84	150	216	75	127	191	143	200	317
80	92	157	234	77	124	218	66	128	215	170	238	316	162	234	314	110	180	250	99	154	222	177	234	347
90	127	194	272	112	162	261	99	165	255	197	269	352	186	263	349	134	208	280	120	178	250	207	263	371
100	158	227	305	145	197	298	130	197	289	219	294	380	206	286	376	156	233	308	140	200	275	234	288	390
110	166	255	332	176	229	331	158	225	316	237	314	402	221	304	397	176	256	332	157	220	296	256	309	405
120	211	279	355	205	258	360	183	250	339	251	329	418	232	316	410	196	277	354	173	238	316	276	326	418
130	234	301	375	231	284	385	206	271	358	262	340	428	238	322	417	213	296	375	188	253	332	294	341	429
140	254	320	393	254	306	405	225	288	374	271	350	439	245	330	426	226	309	388	198	264	344	308	354	438
150	273	337	408	274	325	421	242	304	387	280	359	449	251	337	435	237	320	399	207	272	352	322	366	446
160	288	351	421	290	340	434	254	314	396	283	363	453	251	338	436	245	327	406	212	278	357	325	368	44[illegible]
170	303	363	432	304	352	444	266	324	404	287	366	456	252	339	436	250	332	411	216	281	360	328	371	449
180	315	375	441	316	362	452	276	332	411	289	369	458	253	339	437	253	334	412	217	282	361	331	372	450
190	327	385	450	326	371	458	285	339	416	291	371	460	253	340	437	254	334	411	217	281	359	334	374	451
200	337	393	457	336	379	464	293	346	422	293	373	462	253	340	437	257	336	413	219	283	361	336	376	452
210	347	401	464	346	387	471	300	352	426	295	374	463	254	340	438	260	339	415	221	285	362	338	377	453
220	355	408	469	354	395	476	307	357	430	297	376	465	254	341	438	263	342	418	223	287	364	340	378	454
230	363	415	475	362	401	481	313	362	434	298	377	466	255	341	438	266	344	421	225	288	366	341	379	455
240	370	421	479	370	407	485	319	366	437	300	379	467	255	341	438	269	347	423	227	290	367	343	380	455
250	377	426	483	376	413	489	324	370	440	301	380	468	255	341	438	271	349	425	229	292	369	344	381	456
260	382	430	486	383	418	493	329	374	442	302	381	469	255	342	439	274	351	427	230	293	371	345	382	456
270	388	435	489	388	422	496	333	377	444	303	382	470	256	342	439	276	353	429	231	295	372	346	382	456
280	393	438	492	393	426	499	337	380	446	304	383	470	256	342	439	278	355	431	233	296	373	347	383	457
290	397	442	494	398	430	502	341	382	448	305	383	471	256	342	439	279	357	433	234	297	375	348	384	457
300	401	445	496	402	433	504	344	385	450	306	384	472	256	342	439	281	359	435	235	298	376	349	384	457

Table 101 continued: Secondary analysis unit yield tables (m^3/hectare) for existing natural stands VRI Phase II (en2) using VDYP

Age (years)	Cottonwood/Deciduous			Spruce/Larch			Subalpine Fir			Birch		
	091 en2	092 en2	093 en2	101 en2	102 en2	103 en2	111 en2	112 en2	113 en2	121 en2	122 en2	123 en2
10	0	0	0	0	0	0	0	0	0			
20	0	0	6	0	0	0	0	0	0	0	0	0
30	0	2	94	0	0	0	0	0	6	0	3	25
40	0	36	180	0	0	24	0	5	32	9	48	88
50	25	88	244	0	13	85	2	19	73	34	97	145
60	65	136	292	10	57	143	12	46	112	62	140	195
70	103	176	329	42	99	194	33	76	150	90	179	239
80	136	211	357	76	137	239	52	101	182	115	212	276
90	166	240	379	107	171	277	70	124	210	138	242	310
100	192	264	397	136	202	310	86	146	234	159	269	339
110	215	285	411	163	229	339	101	165	256	177	292	365
120	235	303	423	187	253	363	114	183	275	194	313	388
130	252	317	432	209	274	385	128	199	297	205	325	400
140	265	329	440	228	292	403	141	212	317	210	330	405
150	278	340	446	244	307	416	154	226	337	214	335	410
160	279	340	446	257	319	426	166	236	355	217	338	412
170	280	341	447	267	328	434	178	246	372	219	340	414
180	281	342	447	276	336	440	189	255	389	221	341	415
190	282	342	447	285	344	446	199	264	405	223	343	417
200	282	343	447	292	350	451	210	273	419	225	344	418
210	283	343	447	299	356	455	220	281	434	226	346	419
220	284	343	447	304	361	459	229	289	447	227	347	420
230	284	344	448	310	366	463	238	297	460	229	348	421
240	285	344	448	315	370	466	247	304	473	230	349	422
250	285	344	448	319	373	469	256	311	485	231	350	422
260	286	345	448	323	377	471	258	312	487	232	350	423
270	286	345	448	327	380	473	260	313	488	233	351	424
280	286	345	448	330	382	475	262	314	490	234	352	424
290	287	345	448	333	384	476	264	315	492	234	352	424
300	287	345	448	335	386	478	266	315	493	235	353	425

Table 102: Secondary analysis unit yield tables (m^3/hectare) for existing managed stands VRI "roll over" (emr) using TIPSY

Age (years)	Spruce	Pine	
	012 emr	062 emr	063 emr
10	0	0	0
20	0	0	1
30	0	15	43
40	0	67	123
50	14	129	197
60	64	182	255
70	131	226	304
80	191	262	339
90	246	292	369
100	303	314	394
110	350	333	416
120	385	349	434
130	412	363	446
140	431	374	453
150	449	384	459
160	460	393	465
170	473	397	470
180	480	405	472
190	488	407	471
200	495	413	472
210	499	416	472
220	499	419	472
230	497	417	472
240	494	417	473
250	493	414	473
260	493	413	473
270	488	411	474
280	484	411	474
290	484	411	474
300	485	410	474

Note: there are no existing managed stands in the THLB that contained VRI Phase II inventory.

Table 103: Secondary analysis unit yield tables (m^3/hectare) for current/future managed stands VRI "roll over" (cfmr) and Phase 2 (cfm2) using TIPSY

Age (years)	VRI "roll over"									VRI Phase 2								
	Spruce			Spruce/Pine			Pine			Spruce			Spruce/Pine			Pine		
	011 cfmr	012 cfmr	013 cfmr	021 cfmr	022 cfmr	023 cfmr	061 cfmr	062 cfmr	063 cfmr	011 cfm2	012 cfm2	013 cfm2	021 cfm2	022 cfm2	023 cfm2	061 cfm2	062 cfm2	063 cfm2
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2
30	0	0	0	0	0	1	0	11	52	0	0	0	0	0	0	0	11	54
40	0	1	20	0	0	48	4	54	136	0	1	24	0	0	19	9	55	138
50	1	22	98	0	14	151	23	109	208	1	25	107	1	11	97	34	112	212
60	13	82	189	5	63	244	51	158	267	18	86	198	13	53	188	66	161	270
70	47	151	265	29	126	337	81	198	313	63	157	281	47	114	265	97	200	316
80	94	211	344	69	187	402	108	232	346	114	218	354	94	175	344	127	236	350
90	146	269	398	114	240	446	132	261	376	167	274	407	146	227	399	152	265	378
100	190	328	433	161	294	476	153	286	401	211	333	445	191	278	434	174	290	403
110	232	370	462	200	343	500	171	302	420	254	377	470	233	329	461	191	307	423
120	272	400	483	238	380	517	185	319	439	300	404	489	273	367	483	206	321	440
130	314	425	497	276	404	525	200	332	449	339	430	506	315	395	498	220	335	450
140	346	443	511	313	426	524	211	341	456	368	446	517	347	417	511	231	344	458
150	374	458	519	341	442	524	220	350	463	391	462	521	374	435	517	241	353	463
160	392	471	517	368	456	525	229	357	467	409	475	519	392	447	516	249	360	467
170	409	481	518	385	467	523	236	365	471	424	485	516	409	460	516	256	367	469
180	423	491	514	401	478	520	241	370	472	434	492	518	422	471	515	262	372	470
190	433	496	514	414	484	519	245	374	471	445	499	515	433	478	514	268	377	469
200	440	500	514	424	491	515	249	376	472	452	502	515	442	484	512	273	378	470
210	450	502	513	433	495	513	255	378	472	461	502	513	450	490	513	278	380	470
220	456	500	509	440	497	512	259	380	472	468	500	507	457	494	510	280	383	470
230	461	498	506	447	497	512	261	382	472	472	500	507	463	493	507	281	384	470
240	468	498	503	454	494	512	265	382	473	475	496	502	468	493	503	282	386	471
250	471	493	500	456	493	512	268	383	473	479	493	499	471	490	500	282	387	471
260	474	491	498	463	492	512	270	384	473	482	490	496	474	490	498	284	387	471
270	476	488	497	466	489	512	271	385	474	482	491	496	476	489	495	284	388	471
280	478	490	493	467	487	512	270	385	474	479	490	496	479	486	493	283	390	472
290	476	488	493	469	481	512	270	385	474	478	487	496	476	483	493	286	391	472
300	476	484	493	471	480	512	267	387	474	478	484	496	475	480	493	285	392	472

Appendix 7: Landscape Unit and Biodiversity Emphasis Options

Landscape Unit	BEO	AT %	BWBS %	SWB %	Landscape Unit	BEO	AT %	BWBS %	SWB %
Akue	I	0	100	0	Klua	I	0	100	0
Big Beaver	I	0	100	0	Kwokullie	I	0	100	0
Boreal	I	26	16	58	Kyklo	L	0	100	0
Bunch	L	0	88	12	La Biche	I	0	100	0
Capot Blanc	I	0	100	0	Liard Hot Springs	I	0	70	30
Catkin	I	0	100	0	Liard River A	I	0	98	2
Chee	I	0	34	66	Liard River B	I	0	100	0
Coal	L	0	94	6	Liard River C	H	0	100	0
Crehan	I	33	8	59	MacDonald	I	25	6	68
Crow	I	0	99	1	Major Hart	I	19	23	58
Crusty	I	0	71	29	Matulka	I	9	18	73
D Easum	L	0	100	0	Minaker	I	0	95	5
Dilly	L	0	100	0	Moose	I	58	0	42
Dunedin	I	0	94	6	Moule	L	0	75	25
Eight Mile	L	9	13	78	Muncho	L	28	10	62
Elleh	L	0	100	0	Muskwa River A	L	0	89	11
Eskai	L	0	100	0	Muskwa River B	L	0	100	0
Etane	I	0	100	0	Netson	I	32	8	60
Falk	I	0	71	29	Ootta	I	0	100	0
Forcier	L	4	43	53	Otelsas	I	54	0	46
Fort Nelson River A	L	0	100	0	Patry	I	0	100	0
Fort Nelson River B	L	0	100	0	Petitot River	I	0	100	0
Gammer	I	0	76	24	Pouce	L	0	100	0
Gathto	L	50	2	48	Prophet River	L	0	100	0
Gemini	I	0	98	2	Rabbit	L	0	76	24
Graybank	L	0	91	9	Racing	L	67	0	33
Grayling	L	4	33	63	Ram	L	6	31	64
Gundahoo	I	20	5	75	Redpott	I	4	18	78
Hay River	I	0	100	0	Richards	L	14	6	80
Hewer	I	28	6	66	Sahtaneh	L	0	100	0
Hoffard	I	0	100	0	Sandy	I	0	100	0
Holden	L	0	79	21	Scatter	I	4	60	36
Hossitl	L	0	100	0	Sharktooth	L	46	9	45
Irene East	I	0	100	0	Shekilie	L	0	100	0
Irene West	H	0	100	0	Smith	I	0	85	15
Jackknife	L	0	100	0	Snake	I	0	100	0
July Lake	L	0	100	0	Stanolind	L	0	100	0
Kechika River	H	0	91	9	Sulpher	L	7	44	49
Kitza	I	0	96	4	Tentsi	I	34	12	54
Kiwigana	I	0	100	0	Tetsa	L	40	0	60
Kledo	I	0	100	0	Timberwolf	I	0	100	0
Klowee	I	0	100	0	Tuchodi	L	42	3	55
Klua	I	0	100	0	Vents	L	0	64	36

Appendix 8: Minimum Harvest Ages

Table 104: Minimum harvest age based on minimum volume (140m^3/ha) and 95% of maximum MAI for existing natural stands

Species Group	Secondary Analysis Unit	VRI "Rolled Over"		VRI Phase II	
		Age at 95% Max. MAI	Age at 140 m^3/ha	Age at 95% Max. MAI	Age at 140 m^3/ha
Spruce	011	120	100	115	95
	012	95	80	95	80
	013	80	65	80	65
Spruce/Pine	021	135	105	125	100
	022	110	85	110	85
	023	85	60	90	65
Spruce/Deciduous	031	130	115	125	105
	032	105	90	105	85
	033	85	70	85	65
Aspen/Coniferous	041	80	85	80	75
	042	75	65	70	60
	043	65	55	65	50
Aspen/Deciduous	051	80	90	75	75
	052	70	65	70	60
	053	65	50	65	50
Pine	061	110	100	105	95
	062	80	70	80	70
	063	65	55	65	55
Pine/Deciduous	071	110	115	100	105
	072	85	85	80	75
	073	70	65	65	60
Cottonwood/Coniferous	081	80	80	85	70
	082	65	65	70	60
	083	50	45	45	40
Cottonwood/Deciduous	091	90	85	95	85
	092	75	70	75	65
	093	50	50	45	35
Spruce/Larch	101	125	110	120	105
	102	105	95	100	85
	103	70	55	80	60
Subalpine Fir	111	150	170	140	140
	112	95	95		100
	113	85	70		70

Table 105: Minimum harvest age based on minimum harvest volume (140m^3/ha) and 95% of maximum MAI for Existing Managed Stands

Species Group	Secondary Analysis Unit	VRI "Rolled Over"	
		Age at 95% Max. MAI	Age at 140 m^3/ha
Spruce	012	103	75
Pine	062	65	55
	063	55	45

Table 106: Minimum harvest age based on minimum harvest volume (140m^3/ha) and 95% of maximum MAI for Future Managed Stands

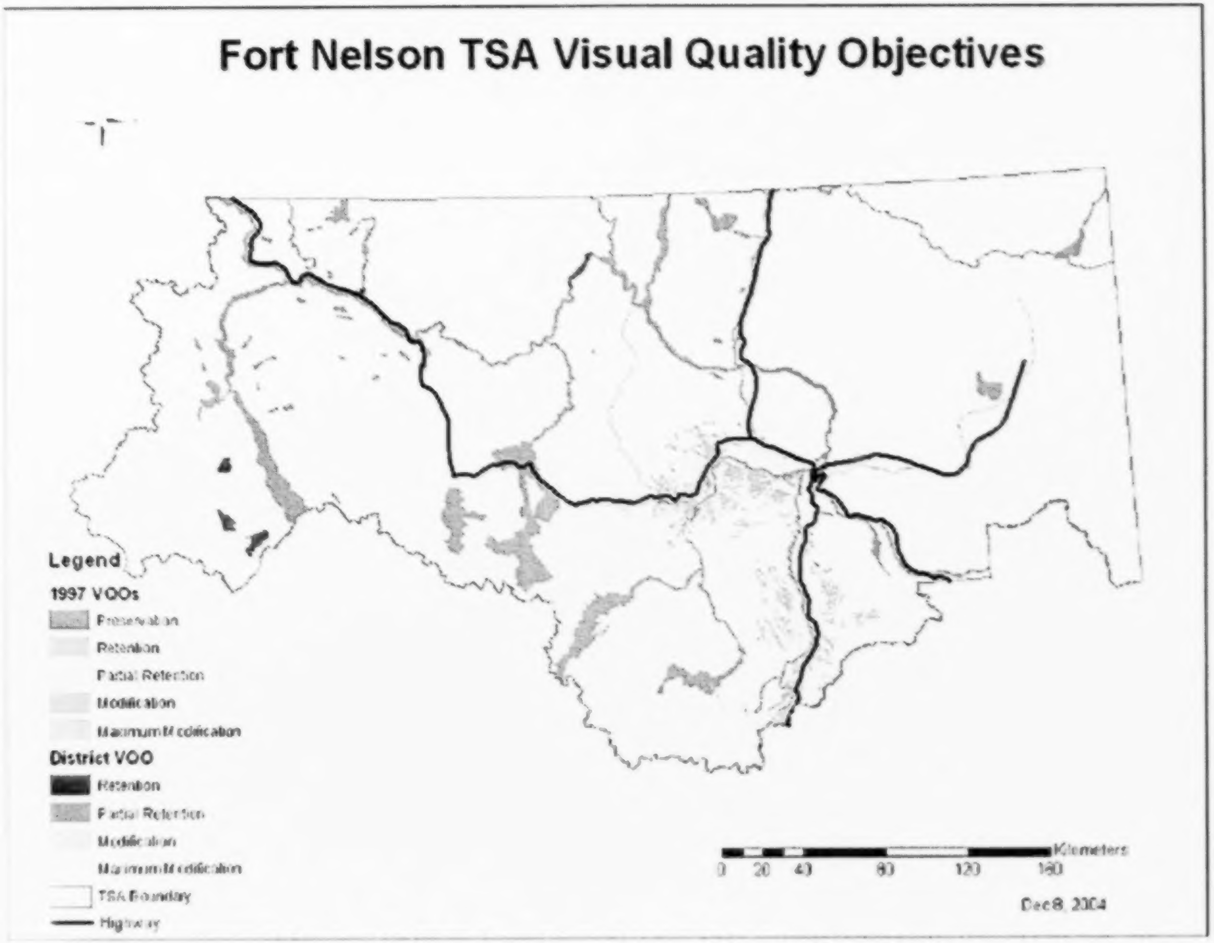
Species Group	Secondary Analysis Unit	VRI "Rolled Over"		VRI Phase II	
		Age at 95% Max. MAI	Age at 140 m^3/ha	Age at 95% Max. MAI	Age at 140 m^3/ha
Spruce	011	125	90	120	85
	012	98	70	96	70
	013	78	55	75	55
Spruce/Pine	021	136	95	125	90
	022	102	75	105	75
	023	70	50	78	55
Pine	061	95	95	86	90
	062	65	60	68	60
	063	55	40	55	45

Appendix 9: List of Parks and Protected Area in the Fort Nelson TSA

Parks and Protected Areas*	Area (ha)
Andy Bailey	196
Dall River Old Growth	644
Denetiah	90,315
Denetiah (PA)	7,445
Dune Za Keyih	63
Fort Nelson River - (ER)	119
Goguka Creek	435
Grayling River Hotsprings - (ER)	1,421
Hay River	2,324
Hornline Creek	298
Jackpine Remnant - (PA)	148
Kledo Creek	6
Klua Lakes - (PA)	28,040
Kotcho Lake - (ER)	31
Kotcho Lake Village	34
Kwadacha Wilderness	38
Liard River Corridor	81,202
Liard River Corridor - (PA)	2,211
Liard River Hotsprings	1,082
Liard River West Corridor	5,576
Maxhamish Lake	605
Maxhamish Lake - (PA)	26,911
Muncho Lake	86,079
Northern Rocky Mountains	666,009
Northern Rocky Mountains - (PA)	764
Parker Lake - (ER)	214
Portage Brule Rapids - (ER)	724
Portage Brule Rapids - (PA)	428
Prophet River Hot Springs	185
Prophet River Wayside	113
Redfern - Keily	65
Scatter River Old Growth	1,178
Smith R. Fort Halkett	244
Smith River - (ER)	1,289
Stone Mountain	25,179
Tetsa River	103
Thinahtea North - PA	3,675
Thinahtea South - PA	16,709
Toad River Hotsprings	414
Total:	**1,052,516**

R = ecological reserve, PA = protected areas, otherwise it is a park. Data source: WLAP BC Parks map

Appendix 10: Map of Areas with Visual Quality Objectives



Fort Nelson TSA Visual Quality Objectives

Legend
1997 VQOs
Preservation
Retention
Partial Retention
Modification
Maximum Modification
District VQO
Retention
Partial Retention
Modification
Maximum Modification
TSA Boundary
Highway
0 20 40 80 120 160
Kilometers
Dec 8, 2004

Appendix 11: SIBEC analysis

In the Fort Nelson TSA, there are a total of two PEM projects (Muskwa-Kechika and Patry) and six TEM projects (Smith/Vent, Snake, Sandy, Sahtaneh, Dunedin and Labiche) that have been completed but accuracy tests are currently at various stages of completion. The biogeoclimatic classification site series data from these projects were used for the SIBEC sensitivity analysis.

SIBEC adjustments are applied to PEM and TEM areas containing existing and future managed coniferous stands and where SIBEC adjustments (2005 approximations) are available. The PEM and TEM may contain more than one site series for an area. In these cases, the SIBEC adjustments were weighted based on the corresponding site series and deciles. Areas with SIBEC adjustments were area-weighted for each secondary analysis unit and if the SI were different from the SI range defined for each secondary analysis unit, these areas would be reassigned to the nearest growth and yield curve (or analysis unit). For areas with a SIBEC adjustment, a comparison between the Inventory SI and the SIBEC is provided in Table 107 and Table 108 for existing and future managed stands, respectively.

Table 107: Inventory SI and SIBEC comparison for existing managed stands

Primary Analysis Units	Secondary Analysis Units	VRI Type	Inventory Site Index for all stands in the THLB	Inventory Site Index for Stands with SIBEC adjustment only	Site Index for stands with the SIBEC adjustment	THLB (ha) with SIBEC adjustments
1	12	rolled over	15.27	15.61	15.36	2,179
6	62	rolled over	17.35	17.00	15.00	40
6	63	rolled over	20.00	20.00	17.13	226

Table 108: Inventory SI and SIBEC comparison for future 'managed' stands (includes stands from natural regeneration)

Primary Analysis Units	Secondary Analysis Units	VRI Type	Inventory Site Index for all stands in the THLB	Inventory Site Index for Stands with SIBEC adjustment only	Site Index for stands with the SIBEC adjustment	THLB (ha) with SIBEC adjustments
1	11	Phase 2	12.81	12.93	14.20	14,439
1	11	rolled over	12.22	12.71	14.34	21,941
1	12	Phase 2	15.90	15.84	14.58	12,120
1	12	rolled over	15.73	15.78	15.44	21,574
1	13	Phase 2	19.81	19.79	14.57	5,308
1	13	rolled over	19.43	19.43	16.34	3,803
2	21	Phase 2	12.24	12.18	13.99	610
2	21	rolled over	11.39	11.15	13.45	972
2	22	Phase 2	14.58	14.41	12.84	886
2	22	rolled over	14.95	14.49	12.56	2,866
2	23	Phase 2	19.40	20.09	12.86	481
2	23	rolled over	21.38	19.67	12.39	648
3	31	Phase 2	12.18	12.23	14.89	7,167
3	31	rolled over	11.60	11.79	14.31	4,934
3	32	Phase 2	15.41	15.49	14.80	24,625
3	32	rolled over	14.98	15.11	14.67	18,626
3	33	Phase 2	19.97	20.06	14.83	10,664
3	33	rolled over	20.65	20.68	15.68	2,741
6	61	Phase 2	12.25	12.53	14.48	11,274
6	61	rolled over	11.58	12.05	12.06	37,597
6	62	Phase 2	16.06	15.60	14.72	7,395
6	62	rolled over	15.95	16.25	12.87	17,606
6	63	Phase 2	20.04	19.74	16.66	536
6	63	rolled over	19.92	19.88	11.87	20,581
7	71	Phase 2	13.08	13.12	14.57	2,817
7	71	rolled over	11.40	12.80	14.23	806
7	72	Phase 2	16.37	16.05	15.07	5,593
7	72	rolled over	15.82	16.12	13.90	4,729
7	73	Phase 2	20.46	20.21	16.16	591
7	73	rolled over	20.12	19.79	12.92	2,405
10	101	Phase 2	12.30	12.23	10.26	207
10	101	rolled over	11.71	10.80	9.00	4
10	102	Phase 2	15.55	15.76	11.42	139
10	102	rolled over	15.24	17.40	11.10	42
10	103	Phase 2	20.92	21.89	15.94	83